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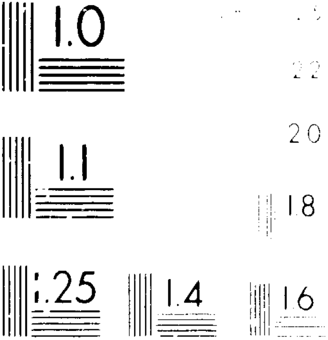
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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Brazil.

METROLOGY, STANDARDIZATION
AND INDUSTRIAL QUALITY . Electronic components.

DP/BRA/82/020

FEDERATIVE REPUBLIC OF BRAZIL

Final Report *

Prepared for the Federative Republic of Brazil
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Thiagarajan RAJARAMAN,
UNIDO Standardization Expert in the field of Electronics

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FINAL REPORT

1. INTRODUCTION

1.1 The UNIDO Project UNIDO/BRA/82/020 has, among other things, the objective of strengthening and consolidating standardization activities of different industrial sectors. The area of electronic components is one such sector.

1.2 After completion of my earlier mission as expert in standardization, I was contracted as an expert in standardization of electronic components. This short mission was from 7 February 1984 to 27 April 1984.

1.3 The objectives of this assignment were:

- assist in evaluating the existing status of standardization in the field of electronic components and recommend steps for accelerating the standards preparation in this field;
- assist in developing priority standards in the field of electronic components;
- help in assessing the applicability of the IEC system for quality assessment of electronic components and advise on measures to be taken by INMETRO for instituting a quality audit system for this sector of industry; and
- training of personnel.

2. WORK ACCOMPLISHED

2.1 Evaluation of the existing status of standardization in the field of electronic components.

2.1.1 The existing status of standardization in the field of electronic components was studied in detail. The following areas were selected, after discussions with the officials of INMETRO and office-bearers of the sub-committee CB 3:1 Electronics of COBEI/ABNT:

- Resistors and capacitors
- semiconductors and integrated circuits
- electromechanical components
- piezo electric devices
- magnetic components and ferrites
- printed circuits.

The complete assessment and recommendations for an accelerated programme after identifying the standards to be prepared are given in Project Report nº 815-84.

2.1.2 For preparing this report, detailed discussions were held with the President and secretary of the concerned sub-committee of the Association of Brazilian Technical Standards (ABNT). Two meetings of sub-committee/ Technical Commissions were attended and visits were made to the secretariat of COBEI (Brazilian Committee for Electricity of ABNT) and industries at São Paulo. Several documents were also studied. These are outlined in the report mentioned in 2.1.1 above.

2.1.3 The important recommendations contained in this report based on the analysis of the existing situation include the following:

a) the availability of standards in the field of electronic components is around 150 and the four year plan (1984-1987) envisages an addition of another 50 standards. There are a number of standards which require updating and revision also. This situation does not satisfy the actual needs. The programme needs review to cater to the growing needs of the industry, which has grown substantially to cater to a market demand of over US$3 billion. The report includes a list of standards listed as priority I and priority II to be prepared in the immediate future.

b) the standards so far prepared and those yet to be prepared require streamlining and harmonization with a view to participating in the international system for quality assessment of electronic components in the near future, in a "specification system" consisting of:

- basic specifications
- generic specifications
- sectional specifications where appropriate
- blank detail specifications
- detail specifications.

It is felt that the study commissions, should try to follow this pattern which will be very advantageous:

c) in order to quicken the pace of standards preparation, it is recommended that the study commissions adopt the international standards, wherever possible, following ISO/IEC Guide nº 21-1981 - Adoption of International Standards in National Standards.

2.2 Quality assessment system

2.2.1 Visits were made to two biggest components' factories in the country namely IBRAPE (Philips Group) and ICOTRON (Siemens Group). It was observed that they are having quality assessment and capability approval from three foreign agencies, two of them major equipment manufacturers in USA and the other Under Writers Laboratories, Inc., USA. These factories are also exporting their components to other countries. Their internal quality control systems are fairly well developed.

2.2.2 In the context of Brazil being an important producer of electronic components with considerable experts, the need for evolution of a national system of quality assessment for electronic components, was highlighted in the First Brazilian Seminar on Standardization in Electronics held in June 1979 at São José dos Campos. One of the factories, visited by the expert, has shown interest in the coverage by a quality assessment system, which has international approval.

2.2.3 Brazil, according to international trade statistics (export-import), in the electrotechnical field, ranks equally with countries like Denmark, Hungary, Israel, Korea, Norway and Poland. These countries are already members of the International electrotechnical Commission Quality Assessment System (IECQA). Furthermore, developing countries like China, India, Korea and Israel have already enrolled with the IECQA system. In this context, it is recommended that Brazil join the system and get into the main stream of the international system. This matter was discussed with the President of CB 3:1 and other officer-bearers of COBEI and a general enthusiasm has been indicated towards such a step. It is also reported that during the next meeting of the directorate (diretoria) of COBEI, this matter will be discussed in detail.

2.2.4 The immediate advantages are:

- to get to know the international trends in this field
- to get all publications relating to the certification management committee, inspection co-ordination committee, etc.
- to get opportunity to attend all meetings of IECQA and be a member of certification management committee and inspection teams.

The long-term objectives will be to prepare the country through an organized national system, which will be in the near future, be capable of getting approval from IECQA. Such a step will facilitate the manufacturers shift from seeking bilateral capability approval from foreign buyers and certification agencies (see 2.2.1) and enhance the national pride of the country as a member of an internationally recognized club of countries involved in the manufacture of quality electronic components.

2.2.4 Furthermore, the development of a highly quality conscious electronic components industry is considered essential for self-sufficiency in the matter of defence electronics (Guerra Eletrônica). In all countries, preparing for a sound and well-established electronics industry, is considered a strategic step for self-sufficiency in respect of modern defence needs.

2.2.5 The complete details of the quality assessment system and recommendations for the steps to be undertaken are outlined in Project Report nº 826-84.

2.3 Priority standards development

2.3.1 Based on the priority and as desired by the officers of INMETRO, who participate in the technical/study commissions of ABNT which prepare national standards in the electronic components field, 17 basic texts were prepared. These are outlined in the Annex. In order to facilitate INMETRO equipping their standards Information Centre with relevant international and national standards, a catalogue of standards for electronic components was also prepared (Project Document nº 812-84).

2.3.2 Being a short mission, only a small area could be covered. However, considerable work remains to be done by INMETRO and the concerned study commissions/sub-committees for covering the priority areas indicated in the Project Report nº 815-84 (see also 2.1.1) and streamlining the standards in a "specification system" as mentioned in 2.1.3.

2.4 Training

2.4.1 The counterpart personnel were given lectures/group discussions on several aspects relating to electronic components standardization by the expert. The topics covered were:

- writing comprehensive standards in the electro-technical group-specially electronic components
- relationship between IEC recommendations and National Standards
- quality assessment system for electronic components
- work done by IEC/TC-56, IECQ and CECC
- reliability engineering as applied to electronic components
- testing of safety isolating components (capacitors and resistor capacitor units) - Exposure to testing of electronic components.

2.4.2 The counterpart personnel were advised to study further the following books, in addition to the relevant national and international standards, so that they can participate in the study commissions/subcommittees of ABNT and contribute effectively to the work of standards preparation:

a) Reliability of electronic components, C. E. Jowell, ILIFFE Books Ltd., London.

b) Electronic components Handbook, Part I, II and III Henny, Walsh & Milaf.

c) Radio Components Handbook, Technical Advertising Associates, Cheltenham, Pennsylvania, USA.

d) Electronic Components Testing, W. F. Walter, Macmillan Engineering Evaluation Series.

2.5 Calibration system

The measurements for factories producing electronic components being precise, it is necessary that they should have a good system of calibration of their measuring instruments and devices. This is also a pre-requisite, as and when, they are covered by a quality assessment system at a later date. It was also understood that one of the study commissions was engaged in the preparation of a document for calibration system. In consultation with the member involved in this task (Com. Waeny of IPT - São Paulo) some notes for calibration system were prepared.

2.6 Participation in meetings/visits to industry

During this short mission, the expert was able to attend meetings of a study commission, a sub-committee and also the meeting of the directorate of COBEI. It provided an opportunity to create enthusiasm with the members for an accelerated programme for standardization in the field of electronic components and quality assessment system for electronic components. It was also possible to visit two major components' factories of the country (Philips and Siemens group) and have discussions with the top officials of these factories. The expert also visited the Electrical Measurements Facility at Xerém Centre of INMETRO, Institute of Research and Technology (IPT) at São Paulo, a defence centre for electronics in Rio de Janeiro and the Electronics Testing Section of the Centre for Aerospace Research (CTA) at São José dos Campos. These provided an opportunity to discuss with concerned officials on the need for electronic components standardization and quality assessment system for the country and appreciate the present status for writing the various reports.

3. RECOMMENDATIONS

3.1 The present programme for standards development in the electronics components field needs review to cater to the growing needs of the industry. The standards so far prepared and yet to be prepared require streamlining and harmonization with a view to participating in the international system for quality assessment of electronic components in the near future. For full details see Project Report nº 815-84.

3.2 It is recommended that Brazil join the IECQA system and get into the mainstream of the international electronic components standardization system. For full details see Project Report nº 826-84. A leadership role should be provided by INMETRO in organizing the system for quality assessment for electronic components and the following components, as explained in Project Report nº 815-84 need to be identified and strengthened:

- National Authorized Institution
- National Standards Organization
- National Supervising Inspectorate.

3.3 It is recommended that priority standards should be developed as quickly as possible as described in Project Report nº 815-84.

3.4 It is recommended that the officers of INMETRO dealing with electronics components standardization be given advanced training in factories and other standards bodies in UK, France, etc. for understanding in depth the working of quality assessment system in practice.

4. CONCLUSION

4.1 The expert likes to point out that the results achieved and the impact of the implementation of BRA/75/003 could be felt in all the industries. This has certainly paved the way for greater consciousness of the importance of standardization and industrial quality for the country.' There is recognition of the benefits of the implementation of BRA/75/003 at the highest levels in the government, ABNT, INMETRO and the industry. This will facilitate the implementation of BRA/82/020.

4.2 During this short and brief mission of effective ten weeks, the expert found a lot of enthusiasm in the industry, officials of testing organizations, ABNT technical commission members to accelerate the programme of standardization in the field of electronic components and development of a national system for electronic components. They expect that an effective leadership role will be provided by INMETRO as the national executive agency of the National System of Standardization, Industrial Quality, Metrology. It is recommended that INMETRO will take adequate measures to follow-up the several recommendations contained in Project Reports nº 815-84 and 826-84 and take advantage of the general enthusiasm generated within Industry and other concerned agencies during this brief mission.

5. ACKNOWLEDGEMENT

5.1 The expert wishes to express his sincere thanks for the guidance given by the Chief Technical Adviser, Mr. B.S. Krishnamachar of the Project and to acknowledge the co-operation received from the officers of INMETRO; COBEI (ABNT), several testing organizations and industries and the secretaries of the Project Ms.Cláudia Regina S. da Silva and Ms. Maria Bernadete da Silva.

6. LIST OF VISITS AND REPORTS

1. VISITS

The Secretatiat of COBEI, São Paulo

Metrology Centre, Xerém, INMETRO

Defence Electronics Laboratory, Rio de Janeiro

Institute of Research and Technology (IPT), Sãc Paulo

Centre for Aerospace Research (CTA), São José dos Campos

Factory - IBRAPE CONSTANTA Division of Philips - near São Paulo

Factory Office - ICOTRON - Division of Siemens - near São Paulo.

2. REPORTS AND DOCUMENTS

11-12/01/B/807-84 - Visit to Xerem (Centre for Industrial and Scientific Metrology)

11-12/02/R/811-84 - Report on the visit to FAET

11-12/03/B/812-84 - Catalogue of standards for electronic components to be provided for the standardization project in Brazil

11-12/04/R/813-84 - Preliminary report by T. Rajaraman

11-12/05/R/820-84 - Report on the visit to secretariat of COBEI (CB 3)

11-12/06/R/815-84 - Assessment of the status of standardization in the field of electronics components

11-12/07/T/816-84 - Reliability engineering (as related to electronics field)

11-12/08/T/817-84 - The relation between IEC recommendations and national standards

11-12/09/R/821-84 - Report on the meeting of CB 3:1 electronics held in São Paulo

11-12/10/R/822-84 - Visit to Centro Aeroespacial

11-12/11/R/823-84 - Report on the visit to IBRAPE Constanta Division of electronics components - Philips Brazil Ltd.- Ribeirão Pires - São Paulo

11-12/12/R/824-84 - Report on the meeting with the President, CB 3:1 - Cel. Humberto Chagas Pradal

11-12/13/S/825-84 - Basic text for the draft standard on semiconductor devices-methods of tests - field effect transistors (Project 3:01-47.1-011)

11-12/14/R/826-84 - Quality assessment system for electronic components

11-12/15/S/827-84 - Basic text for the draft standard on guide to the use of variable capacitors

11-12/16/S/828-84 - Basic text for the draft standard on variable capacitors - Terminology

11-12/17/S/829-84 - Basic text for the draft standard on variable capacitors - Methods of Test

11-12/18/R/830-84 - Requirements for the calibration service in support of a quality assessment system for electric components

11-12/19/S/831-84 - Basic text for the draft standard on letter symbols for semiconductor devices and integrated circuits

11-12/20/R/832-84 - Report on the meeting with Mr. J. A. F. M. Spyker - Vice-Predident, International Subjects - COBEI

11-12/21/R/833-84 - Report on the visit to "Laboratório do Exército", Rio de Janeiro

11-12/22/R/837-84 - Report on the visit to ICOTRON (Siemens) - São Paulo - 11 April

11-12/23/R/838-84 - Final Report.

ANNEX I

ASSESSMENT OF THE STATUS OF STANDARDIZATION IN THE FIELD OF ELECTRONIC COMPONENTS

1. INTRODUCTION

1.1 With a view to establishing an accelerated programme of standardization in the area of electronic components, with in the overall framework of assistance in the field of standardization, industrial quality and metrology (UNIDO/BRA/82/020), an evaluation of the existing status on standardization of electronic components in Brazil has been made and presented in this report.

1.2 Detailed discussions were held with the following officers of INMETRO who are represented in some of the ABNT Study Commissions responsible for standardization in the field of electronic components and who co-ordinate all the activities concerning registration of finalized documents as Brazilian Standards:

- Enga. Juçara Lopes da Silva (Head of Department of Electrotechnical, Electronics, Energy)
- Enga. Darcy Gil Neto Moraes
- Engº Jaime Henrique Reich.

Discussions were also held with:

- Cel. Humberto Chagas Pradal, President CB 3:1
- Engº Antonio Luiz Trancredio Perez, Secretary CB 3:1 (CB 3:1 is the sub-committee on electronics within the Comitê Brasileiro (CB)-2 (ABNT) dealing with all electrotechnical subjects).

1.3 The following documents were studied in detail, to appreciate the present status and most of the statistical data were taken from them:

- Relatório do Primeiro Seminário Brasileiro de Normalização Eletronica;
- Manual de Normalização, Subcomite de Eletronica SC 3:1;
- Órgãos Diretivos do COBEI, 1984;
- Plano de Normalização, Programa de Trabalho, 1984-1987;
- Situação das Comissões Técnicas do SC 3:1;
- IEC Year Book 1982;
- DIN Catalogue of Technical Rules, 1983;
- BSI Year Book and Catalogue of Publications, 1983;
- ISI Sectional List of Standards in Electronics and Telecommunications, 1983.

2. ELECTRONIC COMPONENTS INDUSTRY IN BRAZIL

2.1 The electronics industry in Brazil, after the oil crisis of 1973, has been growing at a tremendous pace owing to the policy of indigenization to cater to a wideranging requirements of entertainment and professional electronic equipment, industrial controls, instrumentation, etc. It is estimated that it caters to a demand of over 3 billion US dollars worth of equipment, some of which is also exported. Due to different collaboration arrangements from various countries within this sector, a large number of [illegible] in the [illegible].

2.2 The magnitude of the electronic components sector within the electronic equipment industry can be assessed from the following table where the average and typical distribution of costs of different types of components required for fabrication of electronic equipment is given:

Type of Component	Per cent of total value
Metallic parts	25
Printed circuits	13
Transformers and inductors	9
Connectors	8
Cables and wires	7
Plastic parts	6,5
Diodes, transistors, capacitors, etc.	6

2.3 The growth of the market for electronic components in Brazil, has been phenomenal in the last few years. The statistical data in terms of quantity and value amplifies this fact through the following tables.

Demand for Electronic Components (by value)
(millions of US$)

Component	1976	1977	1978	1979	1980	1981
Semiconductor devices	88	107	128	145	165	167
Variable resistors	24,4	26,6	30,2	31,1	32,8	34,6
Fixed resistors	14,4	15,5	17,3	17,9	19,1	20,0
Electrolytic capacitors	20,2	22,4	27,6	29,4	32,5	35,7
Ceramic capacitors	9,3	10,0	11,1	12,2	13,3	14,4
Plastic film capacitors	6,6	7,3	8,7	9,4	10,1	10,7

[illegible]

(millions of units)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Variable resistors	55	60	66	70	[illegible]	75
Fixed resistors	650	700	750	[illegible]	[illegible]	[illegible]
Electrolytic capacitors	175	195	230	255	263	310
Ceramic capacitors	300	360	400	330	480	520
Plastic film capacitors	170	190	225	245	[illegible]	275

2.4 Semi conductor devices

In recent years, digital technology has undergone a rapid evolution because of advances in the field of memory, microprocessors and semi conductors. The typical pattern of consumption of semi conductor devices in various sectors of electronics in Brazil is reflected in the following tables:

Pattern of usage of semi conductors in different sectors of electronics in Brazil (percentage)

Sector \ Year	1976	1977	1978	1979	1980	1981
Radio, TV, entertainment	69.3	69.7	73.3	69.9	64.5	64.7
Telecommunications	10.2	8.3	6.5	6.5	7.3	7.3
Data processing	2.3	2.7	2.7	4	5.3	6.3
Other sectors	18.2	19.3	17.5	20.6	22.9	21.7
Total	100	100	100	100	100	100

Estimated Consumption of
Semi Conductors Sector Wise
(Millions of US$)

	Entertain-ment	Tele-communication	Data processing	Others	Total
1978	93,9	8,3	3,5	22,5	128,2
1979	103,2	9,7	6,1	30,7	149,7
1980	110,4	12,4	9,1	39,2	171,1
1981	120,6	13,5	11,8	40,4	186,3
1982	131,2	15,1	13,4	41,8	201,5
1978-1982	559,3	59,0	43,9	174,6	836,8

3. STANDARDIZATION IN THE AREA OF ELECTRONIC COMPONENTS

3.1 Comite Brasileiro (CB)-3 Electricity is the Brazilian National Electrotechnical Committee, responsible for development of standards of all electrotechnical subject which include electronics also. This is within the framework of Association for Brazilian Technical Standards (ABNT). This committee is designated as the Brazilian National Committee for the purpose of participation in the activities of the International Electrotechnical Comission (IEC) which is dealing with standardization of all electrotechnical subjects (including electronics).

3.2 CB-3 has ten sub-com[illegible] as follows:

- SC 3:1 Elect[illegible]nics
- SC 3:2 [illegible]
- SC 3:3 [illegible]
- [illegible]
- [illegible]

- SC 3:6 General subjects
- SC 3:7 Terminology
- SC 3:8 Quality Assurance, Certification, Safety and Consumer Affairs
- SC 3:9 Electrotechnical II
- SC3:10 Electroheating.

Out of the above mentioned sub-committees, the following have to deal with electronics subjects exclusively or partially:

- SC 3:1 Electronics
- SC 3:5 Telecommunications
- SC 3:6 General Subjects
- SC 3:7 Terminology
- SC 3:8 Quality Assurance, Certification, Safety and Consumer Affairs.

3.3 The subcommittees have a number of technical commissions (CT) which contribute maximum amount of technical work in the matter of drafting standards, discussing and finalizing them. The drafts are finalized by ABNT Committees and later approved by the co-ordinating committee of INMETRO dealing with electronics before publication as Brazilian Standards. The technical commissions are numbered in the same manner as the corresponding technical committee of IEC.

For example CT-40 capacitors and resistors for electronic equipment under SC 3:1 is numbered after TC-40 of IEC Capacitors and resistors for electronic equipment. Altogether, there are 84 technical commissions working under the jurisdiction of the ten sub-committees (see 3.2). Some of these technical commissions have study [illegible] (CE) in which case, the major part of work is carried by the study [illegible].

3.4 Electronic components

The following technical commissions and/or study commissions are dealing with the standardization of electronic components (cables, wires and TV tubes being excluded) exclusively or partially.

CT 1 (SC 3:7)		Terminology
CT 3 (CS 3:6)		Symbols for electricity
	CE 3:1	General subjects of electronics
	CE 3:3	Graphical symbols for electrotechnical and electronics subjects
CT40 (SC 3:1)		Capacitors and resistors for electronic equipment
	CE30:1	Capacitors
	CE40:2	Resistors
	CE40:3	Potentiometer
CT47 (SC 3:1)		Semiconductor devices and integrated circuits
	CE47:1	Methods of tests and specifications
CT48 (SC 3:1)		Electromechanical components for electronic equipment
	CE48:1	Sockets
	CE48:2	Connectors
	CE48:3	Plugs
CT49 (SC 3:1)		Piezo electric devices for frequency control and selection
	CE49:1	Quartz crystal oscillators
CT50 (SC 3:1)		Environmental testing
	CE50:1	Climatic and mechanical testing
CT51 (SC 3:1)		Magnetic components and ferrite materials
	CE51:1	Supply transformers up to 1800 va for electronic equipment and [illegible]
	CE51:2	[illegible]
	CE51:3	[illegible]

CT52 (SC 3:1) Printed circuits

CT56 (SC 3:8) Reliability and quality control
CE56:1 Reliability
CE56:2 Quality certification.

3.5 For the purpose of this study, these technical commissions are divided into two groups A and B, one dealing with electronic components (excluding cables, wires and TV tubes) directly and the other dealing partailly the subject of electronic components. The status of standards preparation is given in Annex 1. Quantitatively, it can be summarized as follows:

	CT	Standards	Standards underprint	Drafts under voting
Group A				
Resistors and capacitors	40	58 (32)	17	4
Semi conductors and IC	47	-	1	1
Electromechanical components	48	18 (18)	3	1
Piezo electric devices	49	7 (7)	-	2
Magnetic and ferrites	51	12 (2)	12	6
Printed circuits	52	14 (10)	8	-
Group B				-
Terminology	1	2	-	-
Symbols	3	1	-	-
Environmental tests	50	40 (30)	22	3
Reliability and Quality control	56	9 (6)	-	5
Total		161 (105)	63	25

(The bracketed figures indicate the number of standards more than five years old, published in 1978 or earlier).

4. ASSESSMENT

4.1 Though a good amount of work has been done by the technical commissions dealing with electronic components, there is a great deal yet to be done to cope up with the magnitude of development that has taken place (see 2). Perhaps, one of the reasons could be the phenomenal growth of the electronic industry and the system of standards development not being able to match with that growth. The following table gives an idea of the requirements of standards for electronic components in comparison with some other countries and of IEC.

<u>National Standards developed in some countries and at IEC for electronic components</u>

National/International	Number
Germany (DIN)	1.060
U.K. (BSI)	575
India (ISI)	296
IEC	336
Brazil	153

(These figures exclude complementary standards)

4.2 The pattern of development of standards for electronic components in Brazil is such that, whereas there is a tendency to catch up with the requirements of capacitors, resistors, electromechanical components, piezo electric devices, magnetic and ferrite materials and printed circuits, etc. the development of standards in the field of semi conductors and integrated circuits is very small (only one standard is under print) (see 3.5). The [illegible] of semi [illegible] constitutes more than 60 percent of the [illegible] for entertainment electronics industry which is also called [illegible] electronics (see 2.4). In order to [illegible] wide spread satisfaction among consumers, this area needs high priority in the matter of development of standards. There are also a number of subjects which have to be covered in other areas, taking into account, the pattern of development of standards for electronic components (see 4.1).

4.3 According to the four year (1984-1987) programme 64 subjects are planned to be covered including 13 revisions in the field of electronic components. This means that there will be a net addition of about 51 standards to the existing 156 standards by 1987. This means that by 1988, there will be around 200 standards for electronic components. It can be seen from data listed in 4.1 that this number is rather low when compared to actual needs. It is, therefore, recommended that the programme is reviewed to cater to the growing needs of this sector of industry.

4.4 The interdependence of countries in the matter of trade in the area of electronic components, has necessitated the advent of the International System of Quality Assessment under the aegies of the International Electrotechnical Commission. This is an extension of the European Quality Assessment System for Electronic Components (CECC), as many countries outside Europe such as USA, Japan, China, Australia, South Korea, India are also desirous of derieving the benefits of this system. This development has brought into focus, the unification of standards for electronic components. This has resulted in the issue of standards for electronic components known as "Harmonized System for Quality Assessment of Electronic Components", in United Kingdom, France, Germany, etc. This aspect is covered in a separate report.

4.5 In order to be ready for joining the international system for quality assessment of electronic components, it is necessary to develop the infrastructure for a national system for quality assessment of electronic components. This requires the development and harmonization of adequate standards in this field. Therefore, the concerned study commissions should try to evolve the standards at least to the extent covered by the corresponding IEC recommendations and the new Quality Component (QC) series of IEC specifications.

4.6 In reviewing the quantitative figure of available standards for electronic components, there is tendency for having several standards for a product having different types/categories, which could have been purposefully, combined in a single standard. This will considerably reduce the work load involved on all parties concerned and perhaps accelerate the pace of standards development in areas not covered. A few examples are cited here:

- NBR 5183 - Fixed resistors - Terms and definitions
- NBR 5184 - Fixed resistors - Terms and definitions, Annex 1
- NBR 5185 - Fixed resistors - Methods of tests
- NBR 5186 - Fixed resistors - Methods of tests, Annex 1
- NBR 5187 - Fixed wirewound resistors - Type 1- Methods of tests
- NBR 5188 - Fixed wirewound resistors - Type 2- Methods of tests
- NBR 5189 - Fixed wirewound resistors - Type 1- detailed specification
- NBR 5191 - Fixed wirewound resistors - Type 2- detailed specification.

4.7 In view of the complexity of the coverage for standardization of electronic components, IEC, UK and some other countries are developing the standards in a "specification system" consisting of:

basic specifications

generic specifications

sectional specifications where appropriate

blank detail specifications

detail specifications.

It is considered that the study commissions, should try to follow this pattern which will be very advantageous. The necessity for development of standards in this pattern in order to develop the national system for quality assessment of electronic components is covered in a separate report.

4.8 Adoption of International Standards

4.8.1 In the field of electronics in general and the electronic components in particular, international standards are widely adopted at national level and applied by manufacturers, trade organizations, pruchasers, consumers and testing laboratories, authorities and other interested parties. With the advent of the IEC Quality Assessment System (IECQ), many countries have started adopting International Standards as such. In Germany, even the Central Office document (CO) has been adopted as DIN Standard. The technological absolescence in the electronic components industry is so fast that some standards bodies do not wait till the international recommendations are printed. Germany is a typical example. The publications so adopted are not even translated to German language (IEC publications or Central Office documents are available only in dual languages namely English and French). Such examples are:

- E DIN IEC 50 (CO) 189	General guidance on environmental testing
- E DIN IEC 50A(CO) 141	Mounting of components for dynamic tests
- E DIN IEC 48C (CO) 68	Dimensions for the mounting of single hole bush mounted spindle operated electronic components
- E DIN IEC 319	Presentation of reliability data on electronic components
- E DIN IEC 409	Guide for the inclusion of reliability clauses into specifications for components (or parts) for electronic components.

4.8.2 The study commissions may consider the practices followed by Germany in the matter of adoption of IEC recommendations or Central Office documents in order to develop Brazilian Standards in this field in the shortest possible time. The novel practice of adopting international documents, without necessarily waiting for translation into the national language, is something which can be considered, in the Brazilian context.

4.8.3 In this connection, attention is drawn to ISO/IEC Guide nº 21-1981 Adoption of International Standards in National Standards. The system of translation (with or without reprint of original) as given in this ISO/IEC Guide should be considered by the study commissions/technical commissions for adoption of several IEC recommendations either for new standards or for revisions of the existing standards due for revision. Should there be any need for slight modification or technical deviation, in [illegible] the

Brazilian Standards, it is recommended that the study commissions consider the system of indication of the degree of equivalence between national and IEC recommendations as given in Addendum 1 of ICS/IEC Guide nº 21.

4.9 The list of standards that are needed to be developed categorized into first phase and second phase priorities are given in Annex 2.

ANNEX 1

STATUS OF STANDARDS PUBLISHED, UNDERPRINTING OR UNDER VOTING (ELECTRONIC COMPONENTS)

A. ELECTRONIC COMPONENTS

A.1 Resistors and capacitors (CT-40)

<u>Published Standards</u>

NBR 5087 (77)	Fixed capacitors, solid dielectric, methods of test
NBR 5088 (81)	Packing of components in continous tapes
NBR 5156 (81)	Copperwires sheathed with nickel or nickel-lead alloys - specification
NBR 5183 (73)	Fixed resistors - Terms and definitions
NBR 5184 (73)	Fixed resistors - Terms and definitions, Annex 1
NBR 5185 (82)	Fixed resistors - Verification of electrical, mechanical and climatic characteristics - Methods of tests
NBR 5186 (73)	Fixed resistors - Methods of tests - Annex 1
NBR 5187 (73)	Fixed wirewound resistors - Type 1 - Selection of methods of tests and general requirements
NBR 5188 (73)	Fixed wirewound resistors - selection of methods of tests and general requirements
NB 5189 (73)	Fixed wirewound resistors - Type 1 - Detailed specification

NB 5190 (73)	Fixed low power non wirewound resistors- selection of methods of tests and general requirements
NBR 5191 (73)	Fixed non wirewound resistors - Type 2- Detailed specification
NBR 5192 (77)	Fixed capacitors - Terms and definitions
NBR 5193 (74)	Film dielectric fixed capacitors - Selection of methods of tests and general requirements
NBR 5194 (74)	Polystyrene film dielectric capacitors - Detailed specification
NBR 5195 (74)	Metallized paper dielectric capacitors - Type 1 and type 2 - Detailed specification
NBR 5196 (74)	Paper dielectric capacitors - Detailed specification
NBR 5197 (74)	Polyester dielectric capacitors - Detailed specification
NBR 5198 (74)	Polycarbonate film dielectric capacitors- Detailed specification
NBR 5199 (73)	Metallized mica dielectric capacitors - Detailed specification
NBR 5200 (73)	Ceramic dielectric capacitors - Selection of methods of tests and general requirements
NBR 5201 (73)	Ceramic dielectric capacitors - Type 1 - Detailed specification
NBR 5202 (73)	Ceramic dielectric capacitors - Type 2 - Detailed specification
NBR 5203 (73)	Fixed aluminium electrolytic capacitors - Selection of methods of tests and general requirements
NBR 5204 (73)	Fixed aluminium electrolytic capacitors - Type 1 - Detailed specification

NBR 5205	(73)	Fixed aluminium electrolytic capacitors- Type 2 - Detailed specification
NBR 5217	(73)	Potentiometers - Terms and definitions
NBR 5218	(73)	Potentiometers - Methods of tests
NBR 5219	(73)	Carbon potentiometers - Selection of methods of tests and general requirements
NBR 5220	(73)	Carbon potentiometers - type 2 - Detailed specification
NBR 5221	(81)	Measurement of the dimensions of a cylindrical component with two axial terminations
NBR 5311	(81)	Colour code for fixed capacitors and resistors
NBR 5316	(74)	Preferred diameters of wire terminations of capacitors and resistors
NBR 5409	(82)	Wires sheathed with nickel or nickel-lead alloys - Methods of tests
NBR 6011	(79)	Maximum dimensions for capacitors
NBR 6012	(79)	Fixed capacitors - Standard series for values
NBR 6013	(80)	Fixed capacitors - Marking
NBR 6014	(80,	Fixed resistors - Marking
NBR 6015	(81)	Inspection of ceramic capacitors - Procedure
NBR 6513	(81)	Electrotechnical and electronics - Resistors, terminology
NBR 6237	(81)	Code for marking of date of production of electronic components (or parts)
NBR 6238	(79)	Fixed resistors - Standard series for values
NBR 6687	(81)	Inspection of polyester and polycarbonate metallized capacitors - Procedure

NBR 6722 (79)	Maximum case dimensions for resistors
NBR 6723 (81)	Fixed capacitors with metallized flat polycarbonate dielectric, climatic category 40/100/21 - Specification
NBR 6725 (81)	Fixed ceramic round capacitor - Type 3 - Climatic category 40/085/21 Specification
NBR 6726 (81)	Fixed ceramic round capacitor - Type 3 - Climatic category 55/085/21 high voltage-specification
NBR 6802 (82)	Fixed capacitor with polyester dielectric, metallized plate type climatic category 40/100/04 - Specification
NBR 6803 (82)	Fixed cylindrical capacitor with polyester dielectric, climatic category 40/085/21 specification
NBR 6806 (82)	Fixed capacitors with polyester dielectric metallized, climatic category 55/085/56-Speficiation
NBR 6978 (76)	Fixed electrolytic capacitors - Terms and definitions
NBR 6981 (82)	Capacitors - Volumetric determination
NBR 7112	Resistors - Volumetric determination
NBR 335-043 (79)	Temperature class identification code-Ceramic capacitors - Type 2
NB 335-26 (76)	Fixed electrolytic capacitors - Methods of tests
NB 348-06 (73)	Guide for preparation of detailed specifications for fixed resistors
NB 348-07 (73)	Guide for preparation of detailed specifications for fixed capacitors with solid dielectric
NB 348-09 (73)	Guide for preparation of detailed specification for electrolytic [illegible]

Standards underprint

NB 355-02	Fixed capacitors - Methods of tests
3:40.1-002	Fixed ceramic round capacitors - Type 2 - climatic category 55/085/21 - Medium voltage-specification
3:40.1-003	Fixed capacitors with polyester dielectric - Metallized, plate type, climatic category 40/100/21 - Specification
3:40.1-011	Fixed ceramic capacitor disk style, type 2, climatic category 55/085/21, low voltage specification
3:40.1-012	Fixed ceramic capacitor disk style, type 1, climatic category 55/085/21, medium voltage-specification
3:40.1-013	Fixed ceramic capacitor disk style, type 1, climatic category 55/085/21, high voltage, specification
3:40.1-021 (EB 1003)	Fixed aluminium electrolytic capacitor, cylindrical, uni-directional, climatic category 40/085/56 - Specification
3:40.2-003	Non wirewound fixed resistors, type 1, climatic category 55/155/56
3:40.[illegible]-009	Fixed non wirewound resistor, metallic film, type 1, climatic category 55/125/56, 1 percent maximum variation after climatic test - specification
3:40.2-010	- Do - 0.5% maximum variation - specification
3:40.2-011	Fixed non wirewound resistor, metallic film type 1, climatic category 55/155/56 - Specification
3:40.2-012 ([illegible])	Fixed wirewound resistor, [illegible], type 2, climatic category 40/[illegible]/56-Specification
3:40.3-001	Electrotechnical, electronics - [illegible] terminology

3.01.40.3-003 Rotary potentiometer - Selection of methods of tests and general requirements

3:40.3-005 Potentiometers for low power - Selection, methods of tests

NB 334-03 Fixed wirewound resistor type 1 - Selection of methods of tests and general requirements, procedure

NB 347-02 Potentiometers - Methods of tests.

Draft Standards Undervoting

3:01.40.1-027 Fixed electrolytic aluminium capacitors- Selection of methods of tests and general requirements - Methods of Tests

3:01.40.1-028 Fixed capacitors used in electronic equipment - Methods of tests

3:40.2-004 Inspection of non-wirewound fixed resistors of low dissipation for quality assurance

3:01.40.1-029 Inspection and approval of aluminium electrolytic capacitors - Procedure.

A.2 Semiconductor devices and integrated circuits (CT 47)

Standards printed

Nil.

Standards underprint

3:47.2-001 Semiconductor devices and integrated circuits - Terminology

Draft standards undervoting

3:47-003 Semiconductor devices - Electrical tests- General - Procedure

A.3 Electromechanical components for electronic equipment (CT 48)

Standards published

NBR 5205 (73) Rotary wafer switches (general requirements)

NBR 5207 (73) Rotary wafer switches - Terminology

NBR 5208 (73) Rotary wafer switches - Methods of tests

NBR 5209 (73) Rotary wafer switches with central mounting

NBR 5210 (73) Rotary wafer switches two-hole mounting

NBR 5211 (73) Rotary wafer switches with central mounting: maximum 12 positions, maximum diameter 40mm

NBR 5212 (73) Rotary wafer switches with two-hole mounting: maximum 26 positions, maximum diameter 60mm

NBR 5214 (73) Lever switches - Methods of tests

NBR 5214 (73) Lever switches - Methods of tests

NBR 5215 (73) Lever switches (type 1) general requirements

NBR 5216 (73) Lever switches (type 2) general requirements

NBR 5222 (73) Lever switches used in [illegible] (equipment) - Direction of operation

NBR 5223 (73) Manually operated lever [illegible] in airborne (equipment) general requirements

NBR 5224 (73) Manually operated [illegible]

[illegible] (78) [illegible] voltage

[illegible]

NBR 5370 (72)	Connectors for electrical copper connections
NBR 5381 (58)	Knife switches, non shielded for low voltage.

Standards underprint

EB-1016	Connectors for frequencies below 3 MHz
3:48.2-001	Entry devices for forced terminal fixing - Specification
3:48.2-003	Connectors for frequencies above 3 MHz- General requirements and methods of tests

Standards undervoting

3:48.007	Circular multipole connectors with bayonet or push-pull coupling - Specification

A.4 Piezo electric devices for frequency control and selection (CT 49)

Published Standards

NBR 5246 (74)	Quartz crystals for oscillators - Standard values and test conditions
NBR 5247 (74)	Quartz crystals for oscillators - Guide to the use of quartz oscillator crystals
NBR 5248 (74)	Quartz crystals for oscillators - Standard outlines and pin connections
NBR 5249 (74)	Standard definitions and methods of measurement for piezoelectric vibrators operating over the frequency range up to 3[illegible]Hz
NBR 5250 (74)	Methods for [illegible] of [illegible]
NBR 5251 (74)	[illegible] for [illegible] of [illegible]

	zero phase technique in a π - Network
NBR 5253 (74)	Temperature control devices for quartz crystal units.

Standards underprint

Nil.

Standards undervoting

NB 415-01.1	Quartz crystals for oscillators - Standard values and test conditions (Section I and II) - Revision
3:49.1-001	Quartz crystals for oscillators - Methods of tests

A.5 Magnetic components and ferrite materials (CT 51)

Standards published

NBR 6530 (81)	Aerial rods - Determination of magnetic properties - Methods of tests
NBR 6536 (81)	Guide to the specification of limits of physical imperfections of parts made from magnetic oxides
NBR 6539 (81)	Dimensions of aerial rods and slabs of ferromagnetic oxides
NBR 6540 (81)	Dimensions of screw cores made of ferromagnetic oxides
NBR 6541 (81)	Dimensions of [illegible], pins and rods of ferromagnetic oxides
NBR 6542 (81)	Dimensions of ferrite cores - Type V
NBR 6543 (81)	Dimensions of toroidal type ferrite cores
NBR 6545 (81)	Ferrites - [illegible]
[illegible] (81)	[illegible]
[illegible]	[illegible]

EB 108 (62)	Supply transformers for electronic equipment
EB 476 (72)	Supply transformers for electronic equipment upto 180 KVA

Standards underprint

EB 476	Supply transformers for electronic equipment upto 180 KVA - Specification
MB 1277	Supply transformers for electronic equipment upto 180 KVA - Methods of Tests
3:51.2-002	Dimensions of pins and hollow cores of ferrites
3:51.2-009	Dimensions of ferrite cross cores - Type X
3:51.2-011	Methods of tests for cylindrical cores
3:51.2-013	Dimensions of ferrite cores, type E, EC and EI
3:51.2-015	Calculation of effective parameters of magnetic piece parts
3:51.2-016	Information on ferrite materials appearing in manufacturer's catalogues
3:51.2-017	Classification of ferromagnetic materials and definition of terms
3:51.2-018	Dimensions of ferrite cores - Types U and UI
3:51.2-019	Guide for drafting of performance specifications for cores used in tele-communications
3:51.2-020	Methods of measurement for ferrite [illegible]- Specification

Drafts undervoting

3:51.3-001	Chokes, inductors and reactors - Specification
3:51.3-002	Audio frequency transformers - Terminology
3:51.3-003	Audio frequency transformers - Methods of test
3:51.3-005	Audio frequency transformers - Classification
3:51.3-006	Audio frequency transformers - Specification
3:51.3-007	High frequency transformers for electronic equipment with wide band spread.

A.6 Printed circuits (CT 52)

Published Standards

NBR 5089 (74)	Printed circuits - metal-clad base materials - Test methods
NBR 5090 (74)	Printed circuits - Grading system
NBR 5091 (75)	Guide for design and use of components intended for mounting on boards with printed wiring and printed circuits
NBR 5092 (82)	Printed circuits - Phenolic paper metal clad laminated - type XXX P - Specification
NBR 5093 (82)	Printed circuits - Phenolic paper metal clad laminated, type XXX PC - Specification
NBR 5094 (82)	Printed circuits - Phenolic paper metal clad [illegible] 2 - [illegible]
NBR [illegible] (75)	- do - Type [illegible]-3 - [illegible]

NBR 5096 (74)	Printed circuits - metal-clad epoxy resin glass-cloth, flame retardant type FR-4 - Specification
NBR 5097 (74)	Printed circuits - metal-clad epoxy resin glass-cloth - flame retardant high temperature resistant, type FR-5 specification
NBR 5098 (74)	Printed circuits - copper clad, epoxy glass cloth, type G-10 - Specification
NBR 5099 (74)	Printed circuits - Metal clad, epoxy resin,glass-cloth, high temperature resistance type G-11 - Specification
NBR 5100 (75)	General requirements and methods of measurement for printed wiring
NBR 5318 (82)	Electrotechnical and electronics - Printed circuits - Terminology
NBR 5319 (74)	Fundamental parameters for connectors for boards with printed wiring

Standards underprint

MB 1280	Methods of tests for printed boards
3:52-003	Guide for the design and use of printed boards
NB 425.2.4	Copper-clad laminated epoxy [illegible] resistant printed circuit, type [illegible]R-3 (V-0) - Specification
3:01-52-004	Specification for single [illegible] sided printed boards with out plated - through holes
3:01-52-005	Specification for single [illegible] [illegible]
3:01-52-006	Multilayer printed [illegible]

	3:01-52-007	Specification for single and double sided flexible printed boards without plated-through holes
	3:01-52-008	Specification for single and double sided flexible printed boards with plated-through holes.

<u>Standards undervoting</u>

Nil.

A.7 Terminology (CT-1)

<u>Published standards</u>

NBR 5469	Electrotechnical and electronics - capacitors - Terminology
NBR 6998	Electromechanical components for electronic equipment - Terminology

A.8 Symbols (CT-3)

NBR 5454	Graphical symbols for semiconductor devices and integrated circuits.

B. COMPLEMENTARY STANDARDS FOR ELECTRONIC COMPONENT STANDARDIZATION

B.1 Environmental testing (CT 50)

NBR 5162 (73)	Test Ea: shock
NBR 5163 (73)	Test Ja: Mould growth
NBR 5164 (81)	Test Tb: Soldering - [illegible] to [illegible]
[illegible] (73)	Test Ca: [illegible]
[illegible] 5202 (81)	Test Cb: [illegible]
[illegible] 5203 (81)	Test Fc: [illegible]

NBR 5294 (73) Test Ed: Free fall

NBR 5295 (73) Test Fc: Sinusoidal vibration

NBR 5296 (81) Test Ga: Constant acceleration

NBR 5297 (73) Test Na: Rapid change of temperature - Two chamber method

NBR 5298 (73) Test Nb: Change of temperature - Single chamber method

NBR 5299 (73) Test Nc: Rapid change of temperature - Two shower bath

NBR 5300 (81) Test Nn: Guide for test for change of temperature

NBR 5301 (73) Test Qa and Qb: Sealing

NBR 5302 (81) Test Qf: Sealing, immersion in water

NBR 5303 (81) Test Q.k : Sealing, gas and mass spectroscopy method

NBR 5304 (81) Test Qc: Sealing - Pressure test

NBR 5305 (73) Test U: Mechanical resistance of terminals

NBR 5390 (77) Environmental tests for mechanical resistance for components and electronic equipment - Part 1 - General

NBR 5391 (72) Test CDa: Guide for damp heat test

NBR 5392 (72) Test CDb: Test chamber with constant relative humidity without vapour injection

NBR 5393 (81) Test Da: Accelerated damp heat

NBR 5394 (72) Test Eb: Impact

NBR 5395 (71) Test Ka: Salt mist

[illegible] (72) Test M: [illegible] air p[illegible]

[illegible] (81) Test [illegible]: [illegible] - Test [illegible] gas [illegible]

NBR 5398 (72)	Test Qd: Sealing - Test against liquid leakage
NBR 5399 (72)	Test QC: Sealing: Penetration of liquids
NBR 5400 (72)	Test Qg: Rain control
NBR 5401 (72)	Test T: Soldering
MB 451-II-A (77)	Cold test - General - Test A
MB 451-II Az (77)	Test Aa: Cold - Rapid change of temperature for specimens which can not dissipate heat
MB 451-II-Ab (77)	Test Ab: Cold-gradual change of temperature for specimens which can not dissipate heat
MB 451-II Ad (77)	Test Ad: Cold - gradual change of temperature for specimens which can dissipate heat
MB 451 II B (71)	Test B: Dry heat
MB 451 II C (71)	Tect C: Damp heat
MB 451-II H (73)	Test H: Storage
MB 451 II J (72)	Test J: Mould growth
MB 451 II K (68)	Test K: Salt mist
MB 451 II N (69)	Test N: Change of temperature

Standards [illegible] print

MB 451-II Ad.	Test Ad: cold test with gradual change of temperature for specimens which can dissipate heat
MB 451 II B	Test B: [illegible] heat
MB 451 [illegible] Ba	[illegible]

MB 451 II Bb	Test Bb: Dry heat test with gradual change of temperature for specimens which can not dissipate heat
MB 451 II Bc	Test Bc: Dry heat test with change of temperature for specimens which can dissipate heat
MB 451 II Bd	Test Bd: Dry heat test with gradual change of temperature for specimens which can dissipate heat
MB 451 II Ca	Test Ca: Damp heat: Steady state
MB 451 II CDa	Test CDa: Guide for damp heat test - Method of test
MB 451 II CDb	Test CDb: Test chamber with constant relative humidity without vapour injection - Method of test
MB 451 II Eb	Test Eb: Impact
MB 451 II Ka	Test Ka: Salt mist
MB 451 II Kd	Test Kd: Hydrogen sulphide test for contacts and connection
MB 451 II M	Test M: Low air pressure
MB 451 II Qa	Test Qa and Qb: Sealing
MB 451 II Qd	Test Qd: Sealing - Leakage of liquid
MB 451 II Qe	Test Qe: Sealing - Penetration of liquid
MB 451 II Qg	Test Qg: Rain control
MB 451 II Sa	Test Sa: Simulated solar radiation
MB 451 II T	Test T: Soldering
MB 451 II Ta	Test Ta: Solderability of printed circuit boards with [illegible]
MB 451 II [illegible]	Test [illegible] - [illegible]
MB 451 II [illegible]	Test [illegible] - [illegible] guide

Standards undervoting

3:01.50-012	Test U: Mechanical resistance of terminals
3:01.50.1-045	Test Db: Accelerated damp heat
3:01.50.1-040	Test J: Mould growth

B.2 Reliability and quality control (CT 56)

Published standards

NBR 5425 (75)	Guide for sampling and inspection for quality control and certification
NBR 5426 (75)	Sampling plans and procedures - Inspection by attributes
NBR 5427 (76)	Guide for use of NBR 5426
NBR 5428 (76)	Statistical procedures for determining the validity of inspection by attributes by the suppliers
NBR 5429 (76)	Sampling plans and procedures for inspection by variables
NBR 5430 (77)	Guide for use of NBR 5429
NBR 5462 (82)	Reliability - Terminology
NBR 6531 (81)	Sampling plans for continuous inspection by attributes
NBR 6534 (82)	Sampling plans for qualification of components, based on rate of failure

Standard underprint

Nil.

[illegible]

3:[illegible]-002 [illegible]

3:56.2-003	Preparation of a programme for quality verification
3:56.2-004	Preparation of a programme of inspection
3:01.56.2-001	Preparation of a programme of quality assurance
3:01.56.2-005	Selection and implementation of the standards for preparation of programmes for quality.

ANNEX 2

LIST OF STANDARDS TO BE DEVELOPED FOR ELECTRONIC COMPONENTS

The following list indicates the subject title, prio...ty possible source of reference. Those marked with astrisk (*) are already programmed in the present 1984-1987 plan of work.

1. Resistors and capacitors (CT 40)

Title	Priority	Recommended Reference
*Fixed capacitors for use in electronic equipment: Part 1 - Generic specification (revision of NBR 5087)	I	IEC QC 300.000 (1982)
*Fixed capacitors for use in electronic equipment: Part 2 - Fixed metallized polyethylene terephthalate film dielectric d.c. capacitors	I	IEC QC 300.400 (1982) 300.401 (1982)
*Fixed capacitors for use in electronic equipment: Part 3 - Tantalum chip capacitors	I	IEC 384-3; IEC 40 (Co)52...
*Fixed capacitors for use in electronic equipment: Part 4 - Aluminium electrolytic capacitors with solid or non-solid electrolyte (revision of NBR 5203, 5204 and 5205)	I	IEC 384-5
*Fixed capacitors for use in electronic equipment: Part 5 - Mica dielectric d.c. capacitors for voltages not exceeding 3.000V (revision of NBR 5199)	I	IEC 385-5

Title	Priority	Recommended Reference
*Fixed capacitors for use in electronic equipment: Part 6 - Fixed metallized polycarbonate film dielectric d.c. capacitors	I	IEC 384-6
*Fixed capacitors for use in electronic equipment: Part 7 - Fixed polystyrene film dielectric d.c. capacitors	I	IEC 384-7
*Fixed capacitors for use in electronic equipment: Part 8 - Ceramic dielectric, class 1 (revision of NBR 5201)	I	IEC 384-8
*Fixed capacitors for use in electronic equipment: Part 9 - Ceramic dielectric, class 2 (revison of NBR 5202)	I	IEC 384-9
*Fixed capacitors for use in electronic equipment: Part 10 - Multilayer ceramic chip capacitors	I	IEC 384-10
*Fixed capacitors for use in electronic equipment: Part 11 - Polyethylene - terephthalate film dielectric metal foil capacitors for d.c.	I	IEC 384-11
*Fixed capacitors for use in electronic equipment: Part 12 - Polycarbonate film dielectric metal foil capacitors for d.c.	I	IEC 384-12
*Fixed capacitors for use in electronic equipment: Part 13 - Polypropylene film dielectric metal foil capacitors for d.c.	I	IEC 384-13
*Fixed capacitors for use in electronic equipment: Part 14 - For radio interference suppression	I	IEC 384-14

Title	Priority	Recommended Reference
*Fixed capacitors for use in electronic equipment: Part 15 - Fixed tantalum capacitors with non-solid or solid dielectric	I	IEC QC 300.200
Fixed capacitors for use in electronic equipment: Part 16 - Fixed metallized polypropylene film dielectric d.c. capacitors	I	IEC QC 301.201
*Marking codes for capacitors and resistors (Revison of NBR 6537 and NBR 6013)	I	IEC 62
*Preferred sizes for capacitors (Revision of NBR 6012)	I	IEC 63
Guide for the choice of colours to be used for the marking of capacitors and resistors	II	IEC 425
*Variable capacitors - Part 1 - Methods of tests	I	IEC 418-1
Variable capacitors - Part 2 - Tuning capacitors type A	I	IEC 418-2; 418-2A and 418-2B
Variable capacitors - Part 3 - Trimmer capacitors type B	I	IEC 418-3 and 418-3A
Variable capacitors - Part 3 - Pre-set capacitors type C	I	IEC 418-4 and 418-4A
Guide to the use of variable capacitors in electronic equipment	I	IEC 612
Air dielectric variable capacitors	II	IEC 334-1 and 334-1A
Plastic film dielectric rotary variable tuning capacitors, type 2	II	IEC 415-1
*Fixed resistors for use in electronic equipment - Part 1 - Generic specification (Revision of NBR 5185 and 5186)	I	IEC QC 400.000 (1982)

Title	Priority	Recommended Reference
*Fixed resistors for use in electronic equipment - Part 2 - Fixed low-power non-wirewound resistors (Revision of NB 334.02/04)	I	IEC QC 400.100 (1982) and 400.101
Fixed resistors for use in electronic equipment - Part 3: Type 1 wirewound resistors (Revision of NBR 5187 and 5189)	II	IEC 115-3
*Fixed resistors for use in electronic equipment - Part 4: Fixed power resistors	I	IEC QC 400.200
*Fixed resistors for use in electronic equipment - Part 5: Fixed precision resistors	I	IEC QC 400.300
*Fixed resistors for use in electronic equipment - Part 6 - Type 2 wirewound resistors	I	IEC 266 and 266-A
Guide for pulse testing of resistors	II	IS:9512-1980, Draft amendment to IEC Pub. 115-1
Methods of test for usability of resistors under pulse conditions	II	IS:9470-1979, Draft amendment to IEC Pub. 115-1
*Maximum case dimensions for resistors (Revision of NBR 6722)	I	IEC 451
Method of measurement of non-linearity in resistors	II	IEC 440
Method of measurement of current noise generated in fixed resistors	II	IEC 195 and IS:5027

Title	Priority	Recommended Reference
*Potentiometers - Part 1: Terms and methods of test (Revision of NBR 5217, 5218, project 3:01.40.3-003, NB 347:02)	I	IEC 393-1, 393-1A, 393-1B, 393-1C and 40 (Co) 467
Potentiometers - Part 2: Lead screw actuated pre-set potentiometers	I	IEC 393-2
*Potentiometers - Part 3 - Precision potentiometers	I	IEC 393-3
*Potentiometers - Part 4 - Power potentiometers	I	IEC 393-4
*Potentiometers - Part 5 - Low-power potentiometers (Project 3:40:3-005)	I	IEC 395-5
Directly heated positive step-function temperature coefficient thermistors	I	IEC QC 440.000 and 440.001

A.2 Semiconductor devices and integrated circuits (CT 47)

Title	Priority	Recommended Reference
*Semiconductor devices - Part I - General, (covered by projects 3:47.2-001 and 3:47-003)	I	IEC 147-0; 147-0A; 147-0B; 147-0C; 147-0D; 147-0E; 147-2 and IEC 47 (CO) 754
*Semiconductor devices - low power signal diodes - methods of test	I	IEC 147-2A/2B/2E/2H and 2M
*Semiconductor devices - variable capacitance diodes - methods of test	I	IEC 147-2B/2F/2K and IEC 47 (CO) 755

Title	Priority	Recommended Reference
*Semiconductor devices - bipolar transistors - methods of test	I	IEC 147-2/2C/2M and IEC 47 (CO) 756
*Semiconductor devices - Field effect transistors - methods of test	I	IEC 147-2G/2M and IEC 47 (Co) 756
*Integrated circuits - digital I.C. - methods of test	I	IEC 147-2L
*Integrated circuits - Analogue I.C. - Methods of test	I	IEC 147-2J
*Essential ratings and characteristics - Diodes	I	IEC 147-1/1B/1F/1G/1J
*Essential ratings and characteristics - Transistors	I	IEC 147-1/1J
*Essential ratings and characteristics - Digital integrated circuits	I	IEC 147-1D
*Essential ratings and characteristics - Analogue integrated circuits	I	IEC 147-1E/1H
Essential ratings and characteristics- High-frequency power transistors for amplifier and oscillator application	II	IEC 47 (Co) 753
Semiconductor devices - Reference methods of measurement	I	IEC 147-3/3A
Semiconductor devices - Acceptance criteria and reliability	I	IEC 147-4
Semiconductor devices - Mechanical and climatic test methods	I	IEC 147-5
Semiconductor devices - Terminology	I	IEC

Title	Priority	Recommended Reference
Mechanical standardization of semiconductor devices	I	
Part 1 - Preparation of drawings		IEC 191-1/A/B/C
Part 2 - Dimensions		IEC 191-2/A/B/C/D/E/F/G
Part 3 - General rules for preparation of outline chawings of I.C.		IEC 191-3/A/B
Letter symbols and definitions		
Part 1 - Integrated circuits, blank terminal and non-usable terminal	I	IEC 47 (Co) 740
Part 2 - Digital I.C. - CAMAC - content addressable memory		IEC 47 (Co) 741
Part 3 - Digital I.C. - Three state output		IEC 47 (Co) 742
Part 4 - Analogue I.C.		IEC 47 (Co) 743
Part 5 - Electrostatic - Sensitive devices		IEC 47 (Co) 744
Part 6 - Optoelectronic devices - Photo transistors and diodes		IEC 47 (Co) 745
Part 6 - Optoelectronic devices - Photo couplers		IEC 47 (Co) 746
Part 7 - Transistors		IEC 47 (Co) 747
Part 8 - Thyristors		IEC 47 (Co) 748, 749
Quality assessment system for electronic components: Generic specification for semiconductor devices and integrated circuits	I	IEC 47 (Co) 816
Electrical tests for acceptance and reliability of analogue integrated circuits	I	IEC 47 (Co) 817
Binary floating point arithmetic for microporcessor systems	II	IEC 47-B (Co) 2

A.3 Electromechanical Components (CT 48)

Title	Priority	Recommended Reference
Connectors for radio receivers and associated sound equipment	I	IEC 130-2 and Amendment nº 1
Battery connectors	I	IEC 130-3
Circular multipole connectors with threaded coupling	I	IEC 130-4 and 130-4A
Rectangular multipole connectors with blade contacts	I	IEC 130-5
Rectangular miniature multipole connectors with blade contacts	I	IEC 130-6
Circular multipole connectors with bayonet or push-pull coupling	I	IEC 130-7
*Concentric connectors for audio circuits in radio receivers	I	IEC 130-8
Circular connectors for radio and associated equipment	I	IEC 130-9/9A and 9B
Connectors for coupling an external low-voltage power supply to portable entertainment equipment	I	IEC 130-10
*Edge socket connectors with closed ends and having a contact spacing of 2.54 mm mating either with board-mounted connectors or printed wiring boards with edge board contacts	I	IEC 130-11 and 130-11A
*Multi-row board printed circuit connectors	I	IEC 130-14
Link and test connectors	I	IEC 130-12
*Ultra-miniature board mounted printed wiring connectors spacing 1,27 mm	I	IEC 130-15

Title	Priority	Recommended Reference
*Printed circuit board mounted connectors having two rows of staggered contacts spacing 25,4mm	I	IEC 130-16
Sockets and accessories for electronic plug in devices	I	IEC 149 and its several supplements
Sensitive switches	I	IEC 163, 163-1/1A/1B
Push-button switches	II	IEC 341 and parts
Dimensions of panels and racks	I	IEC 297
*Connectors for frequencies below 3MHz for use with printed circuits	I	IEC 603 and parts
*Basic testing procedures and measuring methods for electro-mechanical components	I	IEC 512 and its 9 parts and supplements
Solderless wrapped connections	II	IEC 48 (Co) 238 Revision of IEC 352
*Connectors for defence applications	I	MIL
*Co-axial connectors	I	MIL
*Trapezoidal connectors	I	MIL

A.4 Piezo Electric Devices for Frequency Control and Selection (CT 49)

Title	Priority	Recommended Reference
*Quartz crystal controlled oscillators general, methods of tests	I	IEC 679-1
*Guide to the use of quartz crystal controlled oscillators	I	IEC 679-2
32KHz quartz crystal units for wrist watches and standard values, methods of tests	II	IEC 689

Title	Priority	Recommended Reference
Guide to the use of temperature control devices for crystal units	II	IS:6537
Synthetic quartz crystals	II	IS:9709;IEC 49 (Co)127
Guide to use of synthetic quartz crystals	II	IEC 49 (Co) 130
Check-list of crystal controlled oscillator characteristics to be specified	I	IEC 49 (Co) 139

A.5 Magnetic Components and Ferrite Materials (CT 51)

Title	Priority	Recommended Reference
*Methods of test for supply transformer upto 180KVA - Revision	I	
*Specification for supply transformer upto 180KVA - Revision	I	
Graphical symbols - Ferrites, cores and magnetic storage practices	I	
*Cores for inductors and transformers for telecommunication	I	IEC 367-1/2 and IEC 51 (Co) 214
Laminations for transformers and inductors for use in telecommunication and electronic equipment	I	IEC 51 (Co) 232
*Strip wound cut cores of grain oriented silicon-iron alloy, used for electronic and telecommunication equipment	I	IEC 329
*Toroidal strip-wound cores made of magnetically soft material	I	IEC 635
*Axial lead cores made of magnetic oxides or iron powder	I	IEC 701 and IEC 51 (Co) 222
*IF transformers and RF coils, methods of tests, terminology specification	I	IS:1512

A.6 Printed Circuits (CT 52)

Title	Priority	Recommended Reference
*Metal-clad base materials for printed circuits - Test methods	I	IEC 249-1/1A/1B/1C/1D
*Flexible copper-clad polyester (PETP) film	I	IEC 249-2F
*Phenolic cellulose paper copper-clad laminated sheet of defined flammability (vertical burning test)	I	IEC 249-2G
Packaging of components on automatic handling - Tape packaging of components on axial leads on continuous tapes	I	IEC 28-6
*Printed circuits - Capability approval procedure and rules	I	BS 9760:1977
Printed circuits - Terminology	I	IEC

A.7 Quality Assessment (CT 56)

Basic rules of quality assessment system for electronic components	I	IEC QC 001.001
Rules of procedure for quality assessment system for electronic components	I	IEC QC 001-002 Sections 1 and 2
Guide for the inclusion of lot-by-lot and periodic inspection procedures in specifications for electronic components	I	IEC 419
Presentation of reliability data on electronic components	I	IEC 319 and IEC 56 (Co) 80
Preliminary reliability considerations	I	IEC 272

Title	Priority	Recommended Reference
Guide for the collection of reliability, availability and maintainability data from field performance of electronic items	I	IEC 362
Managerial aspects of reliability	I	IEC 300
Guide for the inclusion of reliability clauses into specifications for components (or parts) for electronic equipment	I	IEC 409 and IEC 56 (Co) 72

<u>A N N E X II</u>

RELIABILITY ENGINEERING
(As related to electronics field)

1. INTRODUCTION

1.1 Every day we witness a proliferation of new products, complex industrial and weapon systems, high speed continous production systems and new levels in precision and sophistication leading to new complex equipment. As the complexities of a production process increases, the changes of manufacturing a defective item also increase because of probable omissions and commissions at various stages.

1.2 Oneway to ensure the quality of a product is to analyse the performance under conditions in which it is expected to function and find out how long it can work satisfactorily. These tests are specially essential for electronic equipment and components, aeronautic and space components, defence industry components and other emergency requirements. This is because the loss suffered in case of failure of these critical items can be disastarous. In the context of increased occurence of malfunctioning of components, the concepts of reliability have added significance.

1.3 One of the primary objectives of standardization is cost reduction (that is to maximize economic benefits). Therefore, the study of reliability has become so important from standardization point of view, especially in the field of electronic equipment and components, that the International Electrotechnical Commission, has a separate technical committee (TC 56), which has published certain important recommendations in this field.

2. CONCEPT

2.1 Reliability is the concept concerned with prediction, control, measurement and continous reduction of equipment failure rates. The Electronic Industries Association of USA which first spread this concept, defines it as:

> "the probability of a device performing its purpose adequately for the period of time intended under the operating conditions encountered".

For example, a tank (armoured vehicle) should not be bogged down because of the terrain or an electronic watch should not lose time because of summer heat.

2.2 Reliability index is a relative number arrived at to represent the availability of a particular piece of equipment in relation to other pieces. It is possible to combine the critical pieces and give an aggregate reliability index number for a system in relation to similar systems.

3. MANAGERIAL ASPECTS

3.1 Reliability engineering is a combination of management and technical disciplines and has as its objective the assurance of a product's specified performance for a maximum possible period of time. The responsibility should come from a high managerial level in the organization. The management considerations include:

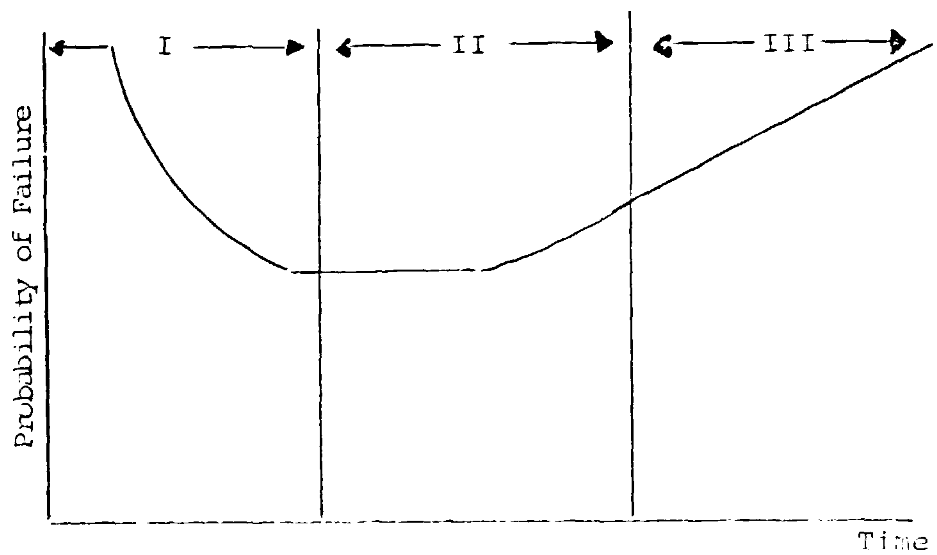
- setting forth reliability objective
- organizing a well-defined programme to eliminate deficiencies
- provision of personnel, funds, authority and time schedule
- constant monitoring of the progress.

3.2 A reliability programme starts with the conceptual phase of the product and continues through design, development, production, testing and field evaluation and service use.

3.3 Even though an ideal equipment is defined as one that will never fail, it is more practical to accept some unreliability and then to minimize the effects as well as duration of a failure when it occurs. This is particularly so because the failure of a component does not always cause total failure of an equipment or a mission.

4. BATH TUB CURVE

4.1 Historically, the first ever attempt to formulate reliability programmes was made in the US Department of Defense (DOD). An Advisory Group on Reliability of Eletronic Equipment (AGREE) was formed by the DOD in 1952, to study the reliability requirements of critical military hardware. Their report submitted in 1957 gave a major impetus to the reliability movement and included the well-known "bath tub curve" of reliability.



I Infantile mortality

II Normal usage

III Oldage mortality stage

4.2 The probability of failure of a manufactured product is similar to the mortality rate of human beings - high during the infant and old stages with a steady low level in between.

4.3 The determination of reliability value is a mathematical process, but once the parameters and the statistical distributions are determined, the job of applying the same to the field situation is easy. In this process, data, such as:

- frequency of failure;
- condition of failure;
- usage rate;
- repairable nature;
- proficiency of operator;
- environmental conditions; and
- warranty claims

are collated.

4.4 The frequency distribution of the failure rate, sometimes follows "Poisson distribution". For example, if the life of an electric bulb is tested, we can obtain the number of failures in a given duration, say, 100 hours. The failure rate will follow a Poisson distribution which, with the "Mean Time Between Failure (MTBF)" form the parameter that can be used to conduct life tests on the product.

4.5 In a few cases, the failure rate may be approximated by a "Normal Curve" or an exponential pattern known as "Weibull" distribution. The above distributions are determined with parameters such as the average failure rate, standard deviation of the rate, natural logrithms and certain constants.

5. DESIGN FEATURE

5.1 Introducing reliability into a product is basically a design feature which has to be implemented at later stages by adequate quality control measures. In complex electronic systems involving a large number of electronic parts, the reliability of each system has to be carefully considered. Another aspect to be remembered is the "debugging period" when failure due to "infantile mortality" will call for replacement of defective parts.

5.2 In order to increase the reliability of a system, usually the principle of "redundancy" is built into a system. Redundancy refers to use of a parallel system so that one of the branches will take over the functions, if a failure occurs in others. This implies the existence of more than one item for accomplishing a given task. Obviously, a cost-benefit analysis has to be carried out before increasing reliability through redundancy.

5.3 The study of reliability and standardizing the design features of complex systems in their company standards are the "high-technology" areas of trans-national corporations engaged in electronics field today.

6. RECENT DEVELOPMENTS

6.1 Reliability improvement is a continuous process involving enormous amount of data-collection. The feed-back information - as in other management processes - includes different sectors of an enterprise, namely designer, manufacturer, marketing, supplier, purchaser, quality control and the user. In this process, conflicts invariably arise and unless there is a moving force to get over these, reliability improvement actions may not even begin. In most of the multi-national companies in the electronic field, the company standards department initiates these activities.

6.2 The National Aeronautics and Space Administration (NASA) in the US has developed, the "Failure Modes Effects and Criticality Analysis" (FMECA) to ensure quality and reliability of complex systems of spacecraft, which consist of numerous sophisticated electronic and mechanical components.

This analysis is a qualitative technique which systematically analyses the failure modes of an equipment. The equipment is split into functional blocks and the possible failures of each block are identified. An attempt is made to deduce the probability of failure on the system. The effects are then analysed and the failures are then ranked according to their criticality. Suitable recommendations are then made for taking the necessary preventive action.

This will help the reliability engineer to change or modify the design, replace low life components, adopt closer tolerances and more rigid test procedures for critical components. Then the critically of each component in relation to the performance of the equipment is quantitatively assessed. The criticality factor measures the probability of failure of the entire equipment due to failure of an individual component. Data on past performance enable the computation of the probability of failures and their prevention by better designing. Experience and judgment on performance of similar equipment come in handy where data are lacking.

7. INTERNATIONAL STANDARDS

7.1 The following IEC standards are available:

- IEC 271 Terms, definitions and related mathematics for reliability
- IEC 272 Reliability considerations

IEC 300 Managerial aspects of reliability

IEC 319 Presentation of reliability data on electronic components

IEC 362 Guide for collection of data on reliability

IEC 409 Guide for inclusion of reliability clauses into specifications for components for electronic equipment

IEC 605 Equipment reliability testing (in several parts).

7.2 In Brazil, an attempt has been made to start work on reliability, by publishing one standard namely NBR 5462 Reliability-Terminology. It is hoped that the rest of the IEC standards will soon be adopted and implemented soon.

8. CONCLUSION

8.1 In view of the high importance of this subject in high technology areas relating to electronic components and equipment, the scope of adopting reliability engineering as a powerful tool for cost reduction (owing to reduction c replacement and failure costs) is indeed very high. Application of reliability engineering techniques in the electronics industry will give a tremendous boost to exports and provide a good support to defence-oriented industries.

ANNEX III

THE RELATION BETWEEN IEC RECOMMENDATIONS AND NATIONAL STANDARDS

1. INTRODUCTION

1.1 The aim of the IEC is to have standards which are uniform throughout the world and yet sufficiently flexible to suit the widely varying conditions existing in different parts of the world.

2. PRACTICES IN DIFFERENT COUNTRIES

2.1 Some countries have highly developed national standardizing organizations and an extensive system of national standards. To them, at least in the beginning, an adjustment to international recommendations is something of a burden and a sacrifice. Others have few national standards and can in many cases be expected to adopt IEC recommendations almost directly as national standards.

2.2 In large or developed countries every alteration, even if it is in itself a clear improvement, may involve a complicated procedure, whereas smaller or developing countries may be able to adapt themselves easily and rapidly to agreements reached.

2.3 There are countries with an extensive home market for which at first sight a unification of standards appears to be of minor importance and others with a large international trade to which international recommendations are of great importance for exports, imports, or both.

2.4 There are countries where, because of reasons of safety, several electro technical standards are legally enforced. On the other hand there are countries which give strong preference to national standards by adopting special measures. There are also countries which are less strict about the degree of implementation of their national standards and are thus more readily prepared to accept deviations.

2.5 IEC recommendations are of a wide range. They include all types of standards.

- terminology
- symbols
- guides (codes of practices)
- methods of tests
- performance requirements
- sampling, etc.
- type, dimensional standards, etc.

However, the trend was to have more of comprehensive specifications including quality and performance in the powerfield, as compared to standards of types and dimensions in the electronics field. Recently even in electronics field more standards on quality and performance are being developed.

3. GENERAL PHILOSOPHY OF IEC

3.1 IEC publicly announces its general policy in the form of a foreword which appears in every IEC recommendation. It reads as follows:

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees

having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendations for their national rules (standards) in so far as national conditions will permit. Any divergence between the IEC recommendations and the corresponding national rules (standards) should, as far as possible, be clearly indicated in the latter.

3.1.1 The first paragraph is almost self explanatory, indicating the strong efforts made by the Technical Committees to produce a truly international consensus of opinion. The loyal, competent and faithful work done by the Chairmen, secretaries and active committee members over several decades has made IEC achieve significant results in international standardization, commensurate with technological advancement in the electrotechnical field.

Some of the IEC Committees have a practice of forward planning to cope with technological advancement in certain sectors, so that standardization is pre-empted to prevent multiplicity of sizes and types and also enables assurance of safety requirements. For example, semi-conductor devices and integrated circuits, miniature fuses for integrated circuits, laser equipment, solar energy equipment, etc.

In certain countries, preparation of national standards based on IEC recommendations in advance, has prevented the prolific increase of multiplicity of sizes and types (e.g.) semiconductor devices.

For example, in India, a large number of dimensional standards on semiconductor devices were brought out based on metric sizes and following IEC recommendations, in anticipation of the expanding growth of this sector.

In Brazil, though the advent of semiconductor is of recent origine, due to lack of national standards, several types based on non-metric dimensions have been introduced. The First Seminar on Electronic Components has highlighted the need for establishing measures for metrication in this sector. Perhaps, if national standards had been established and implemented, non-metric situation need not have taken place in such a new field.

3.1.2 The second paragraph stresses the objective of the IEC to promote international trade by providing documents that could be used as the technical basis for such trade. According to this paragraph, it could be expected that acceptance of an IEC recommendation should indicate readiness to accept it for that purpose, both for export and import.

3.1.3 It is possible that, when an IEC recommendation mainly deals with performance and quality, certain differences may exist between that IEC recommendation and the corresponding national standards. Sometimes, manufacturer who had previously found an export market according to national standards, have to maintain dual standards one for export and the other for national market.

3.1.4 The whole hearted acceptance of paragraph two in the sense outlined above will always present difficulties as long as there are essential differences between IEC recommendations and national standards. In recognition of this fact, the third paragraph emphasizes the need for harmonizing the national standards with IEC recommendations.

3.1.5 The recommendation in the third paragraph, relating to countries with wide areas for standardization in the electrotechnical field yet to be covered, should not present much difficulty. To some extent this paragraph also applies to countries which are nationally active but as yet have no standards corresponding to a given IEC recommendation. In this context ISO/IEC Guide nº 21 and Addendum nº 1, should be widely distributed to all members of the study commission/technical commissions. Where there is divergence between IEC recommendation and the national standard, indication will greatly facilitate international trade and constantly remind those concerned with standardization to gradually eliminate the divergence so as to completely harmonize with IEC recommendation, especially at the time of revision.

4. ADOPTION OF IEC RECOMMENDATIONS

4.1 While it is agreed, that due to different stages of development in developing countries, there may be some problems in adoption of IEC recommendations which concern with performance and quality in specific areas, there should not be many difficulties in adopting methods of tests, dimensions, preferred sizes, terminology, symbols, guides, etc. The practice of adopting IEC recommendations and even IEC central office documents (draft international recommendations) is gaining strength in several countries like UK and Germany.

4.2 It is for consideration for the study commissions of CB-3, particularly those belonging to CB 3:1 to follow this procedure in order to cover a large area at shortest possible time according to ISO/IEC Guide nº 21.

5. ACTIVE PARTICIPATION

5.1 The principle of adoption of IEC recommendations implies active participation of study commissions with the work of corresponding IEC Technical Committees. All preliminary documents/comment of other countries at all stages shall be widely circulated and the study commissions should find time to discuss them, as a matter of routine.

5.2 Responsibility of national committees

When finally an IEC recommendation has been ratified and published, the question again arises as regards the attitude of a National Committee to the recommendation in question. Some National Committees are internationally minded to the extent that as a routine, all national standards committees are required to state the relation of the content to international recommendations in their standards and to explain any differences they have been compelled to introduce. A summary of possible deviations is sometimes even printed in national standards. New international recommendations approved by a country, are announced in the relevant standards committees with the instruction that, since that country has voted in favour of the recommendation, it is essential that deviations should not be made except for very special reasons.

6. ADDITIONAL STANDARDS

6.1 A difficult and delicate question concerns the additional standards issued by many National Committees. A brief glance at lists of standards issued in certain countries as compared with what IEC has managed to achieve is enough to show that the IEC can not possibly in anyway discourage or advise against such activities. If IEC were to try to keep pace with national standardization, its activities would probably have to be manifolded.

7. ELECTRONIC COMPONENTS STANDARDIZATION

7.1 Perhaps, in IEC, this is only one area where the highest order of harmonization has taken place. This may be, to a large extent, ascribed to the evolution of the need for expanding international trade and the attempts having been made by the European countries to harmonize their national standards in this area. The European Electronic Components Committee (CEEC) under the European Standards Committee (CEN) where the European countries have actively participated have developed the harmonized series of standards for electronic components. These were published in UK, Germany and France.

Following this, IEC has recently compiled the harmonized series of standards for electronic components under the series called IECQ and bearing the numbers QC. The earlier recommendations published by IEC are streamlined with this new series.

For example: QC 250.000 = IEC 723-1
QC 300.000 = IEC 384-1
QC 300.200 = IEC 384-15
QC 300.400 = IEC 384-2
QC 300.401 = IEC 384-2-1
QC 300.200 = IEC 384-16
QC 300.201 = IEC 384-16-1

Perhaps this numbering is also to facilitate later on to unify the numbering system of harmonized standards for electronic components at national level also. At national level, UK, Germany and France have identified a special series of number for their harmonized system for standardization of electronic components. This trend indicates that the unification of national and international standards is not in too distant a future, at least in certain areas.

ANNEX IV

BASIC TEXT FOR THE DRAFT STANDARD ON SEMICONDUCTOR DEVICES - METHODS OF TESTS - FIELD EFFECT TRANSISTORS (PROJECT 3:01-47.1-011)

FOREWORD

This standard deals with the methods of tests for field effect transistors and is one of the series of standards on semiconductor devices. This shall be read in conjunction with Projeto de Norma 3:47-003, which deals with the general requirements for electrical tests for semiconductor devices.

This document is based on seventh supplment to IEC Pub 147-2.

1. SCOPE

1.1 This standard deals with methods of tests for field effect transistors of the following types:

Type A: Junction-gate type

Type B: Insulated-gate deflection type

Type C: Insulated-gate enhancement type.

2. GENERAL

2.1 Polarity

The polarities of the power supplies shown in the circuits in this standards, are applicable to N-channel type devices. However, the circuits can be adapted for P-channel type devices by changing the polarities of the meters and power supplies.

2.2 General precautions

The general precautions listed in Doc.: 3:47-003 shall apply. In addition, special care should be taken to use low-ripple d.c. supplies and to decouple adequately all bias supply voltages at the measurement frequency.

For four-terminal devices, the fourth terminal should be connected as specified.

2.3 Precautions for insulated-gate field-effect transistors

Insulated-gate field effect transistors shall be protected against damage from the electric changes which can accumulate on the insulated gate or any terminal which is left open circuited.

In all cases, the gate and source terminals should be short-circuited by means of a suitable switch which should be opened only when measurements are started.

3. GATE CUT-OFF CURRENT OR GATE LEAKAGE CURRENT

3.1 Gate cut-off current of junction-gate type (type A).

3.1.1 Purpose

To measure the gate cut-off current of a junction-gate field-effect transitor under specified conditions.

3.1.2 Circuit diagram

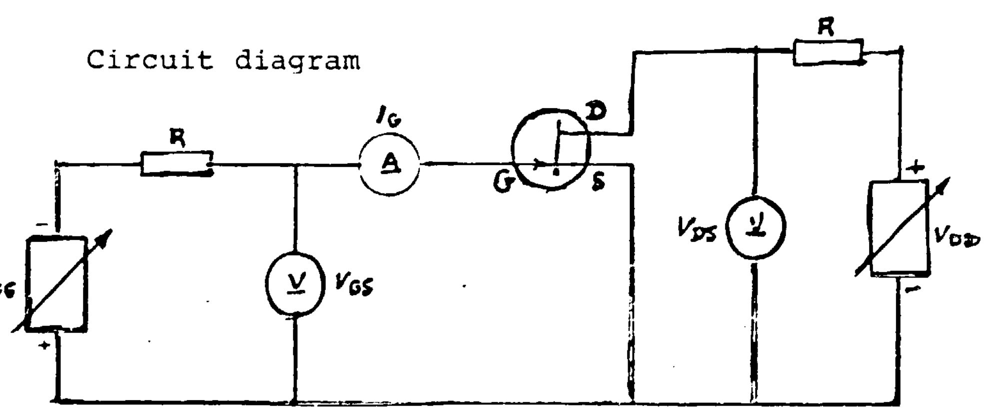


Fig. 1 - Basic circuit for the measurement of gate cut-off current

3.1.3 Measurement procedure

The drain-source voltage is set to the specified value (if this voltage is specified as zero, drain and source terminals should be short-circuited). The gate cut-off current is measured at the specified gate-source voltage, using a sensitive ammeter for I_g.

3.1.4 Specified conditions

- ambient or reference point temperature
- gate-source voltage
- drain-source voltage.

3.2 Gate leakage current of insulated-gate type (types B and C).

3.2.1 Purpose

To measure the leakage current of an insulated-gate field effect transistor, under specified conditions.

3.2.2 Circuit diagram

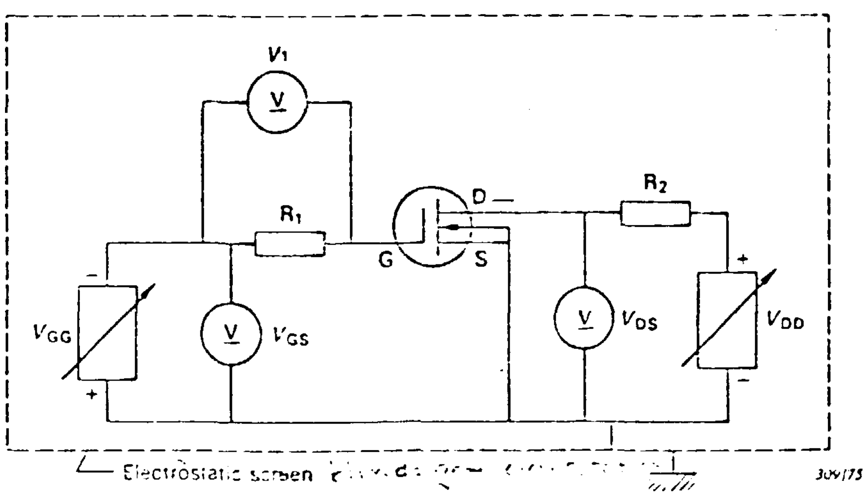


FIG. 2. — Basic circuit for the measurement of gate leakage current.

3.2.3 Circuit description and requirements

The source and substrate terminals are connected together. R is a protective resistor. The value of resistors R1 should be smaller than $V_{gs}/100\ I_{gs}$ max. Voltmeter V1 should have a high sensitivity and an input resistance of more than 100 times R1. The gate leakage current is given by:

$$I_{gs} = \frac{V1}{R1}$$

3.2.4 Precautions to be observed

a) the entire circuit should be placed inside an electrostatic screen.

b) special care should be taken to avoid incorrect measurements caused by leakage currents occurring between the gate terminal and any other node in the circuit.

3.2.5 Measurement procedure

The drain-source voltage is adjusted to the specified value.

The voltage V1 is measured at the specified gate-source voltage and the value of gate leakage current is calculated.

3.2.6 Specified conditions

- Ambient or reference point temperature
- gate-source voltage
- drain-source voltage.

4. DRAIN CURRENT (TYPES A, B AND C)

4.1 Purpose

To measure the drain current of a field-effect transistor, under specified conditions.

4.2 Circuit diagram

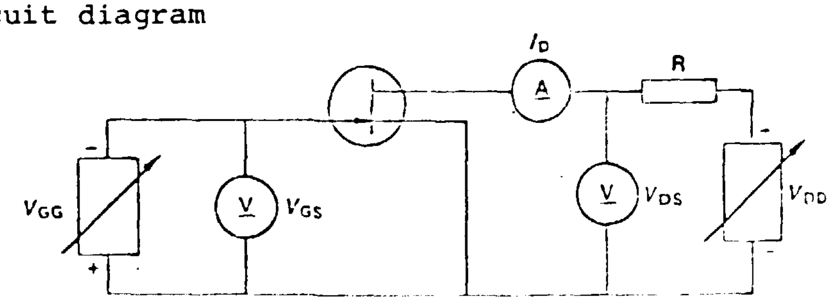


Fig. 3 — Basic circuit for the measurement of drain current

4.3 Circuit description and requirements

R is a protective resistor.

4.4 Precautions to be observed

See general precautions - Doc. 3:47-003.

4.5 Measurement procedure

The specified gate-source voltage is applied to the gate. If this voltage is specified as zero, the gate should be short-circuited to the source.

The drain current is measured at the specified drain-source voltage.

3.6 Specified conditions

- ambient or reference point temperature
- gate-source voltage
- drain-source voltage.

5. DRAIN CUT-OFF CURRENT (TYPES A, B AND C)

5.1 Purpose

To measure the drain cut-off current of a field-effect transistor, under specified conditions.

5.2 Circuit diagram

The circuit of figure 3 may be used for this measurement.

5.3 Precautions to be observed (for types B and C)

The entire circuit should be placed inside an electrostatic screen.

5.4 Measurement procedure

The drain current is chosen so that the device is operating in the cut-off region.

5.5 Specified conditions

- ambient or reference point temperature
- gate-source voltage
- drain-source voltage.

6. GATE-SOURCE CUT-OFF VOLTAGE (TYPES A AND B)

6.1 Purpose

To measure the gate-source cut-off voltage, under specified conditions.

6.2 Circuit diagram

The circuit of figure 3 may be used for this measurement.

6.3 Precautions to be observed

The entire circuit should be placed inside an electrostatic screen.

6.4 Measurement procedure

The specified drain-source voltage is applied.

Note: An additional substrate-source voltage may be applied if necessary.

The gate-source voltage is adjusted to obtain the specified drain current in the cut-off region. This is the required value of the gate-source cut-off voltage.

6.5 Specified conditions

- ambient or reference point temperature
- drain-source voltage
- drain current.

7 GATE-SOURCE THRESHOLD VOLTAGE (TYPE C)

7.1 Purpose

To measure the gate-source threshold voltage, under specified conditions.

7.2 Circuit diagram

The circuit of figure 3, with suitable shield, may be used for this measurement, except that the polarity of the gate-source voltage should be reversed.

7.3 Precautions to be observed

The entire circuit should be placed inside an electrostatic screen.

7.4 Measurement procedure

The specified drain-source voltage is applied.

The gate-source voltage is adjusted to obtain the specified drain current. This is the required value of the gate-source threshold voltage.

7.5 Specified conditions

- ambient or reference point temperature
- drain-source voltage
- drain current.

8. SMALL-SIGNAL SHORT-CIRCUIT INPUT CAPACITANCE C (TYPES A, B AND C)

8.1 Purpose

To measure the small signal input capacitance of a field-effect transistor, under specified conditions.

8.2 Circuit diagram

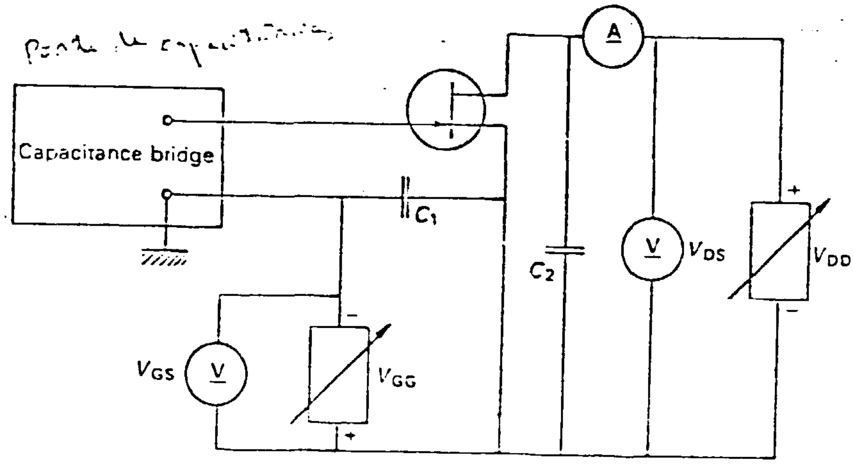


FIG. 4. — Basic circuit for the measurement of small-signal short-circuit input capacitance.

8.3 Circuit description and requirements

A capacitance bridge is used for this measurement. If the bridge can not (or should not) pass d.c. the alternative (shunt) bias circuit shown in Figure 5 may be used.

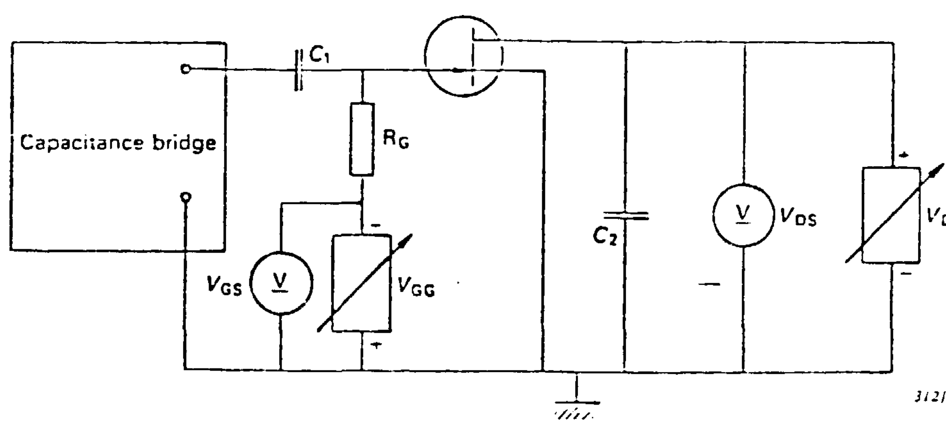


FIG. 5. — Alternative circuit for measurement of small-signal short-circuit input capacitance.

Capacitances C_1 and C_2 should present short-circuits at the measurement frequency, satisfying the following conditions:

$(t)\ C_1 \gg (y_{OS})$

$(t)\ C_2 \gg (Y_{OS})$

8.4 Precautions to be observed

See doc. 3:47-003.

8.5 Measurement procedure

With no device in the measurement socket, the zero adjustments of the bridge are made.

The device to be measured is then inserted into the measurement socket. The drain-source voltage (V_{ds}) and the gate-source voltage (V_{gs}) are adjusted to obtain the specified bias conditions.

The bridge is rebalanced, and the change in the capacitance reading is the value of the small-signal short-circuit input capacitance.

8.6 Specified conditions

- drain-source voltage
- gate-source voltage
- frequency of measurement.

9. SMALL-SIGNAL SHORT-CIRCUIT OUTPUT CONDUCTANGE G_{OS} (TYPES A, B AND C)

9.1 Purpose

To measure the small signal output conductance, under specified conditions.

9.2 General

Two alternative circuits are described, one using a null method, the other using the two voltmeter principle.

The first method requires an admittance bridge but has the advantage that G_{OS} may be measured at high and low frequencies, and that both g_{OS} and C_{OS} may be measured simultaneously.

The second method simply measures the modulus of Y_{os} = g_{os} + jwC_{os} which is identical with g_{os} for sufficiently low frequencies.

9.3 Null method

9.3.1 Circuit diagram

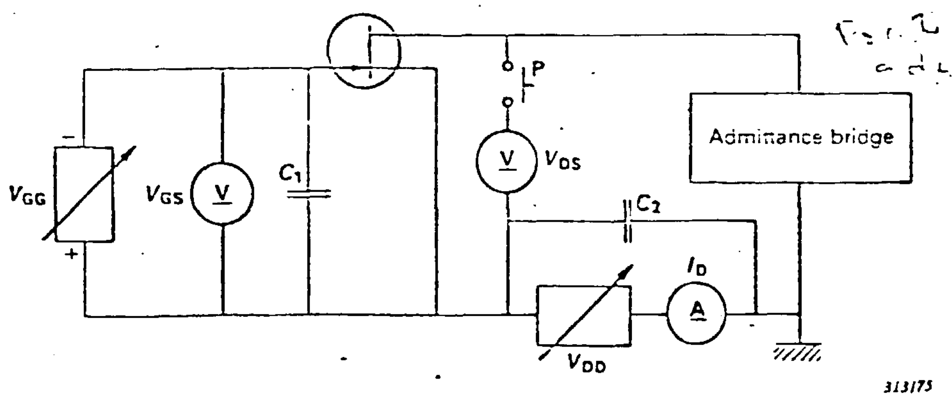


FIG. 6. — Basic circuit for the measurement of the output conductance g_{os} (null method).

9.3.2 Circuit description and requirements

The admittance bridge is used for this measurement.

Capacitances C_1 and C_2 should presente short-circuits at the measurement frequency, satisfying the following conditions:

$$(t)\ C_1 \gg (Y_{os})$$

$$(t)\ C_2 \gg (Y_{os})$$

9.3.3 Precautions to be observed

See general precautions.

9.3.4 Measurement procedure

With no device in the measurement socket, the zero adjustments of the bridge are made.

The device to be measured is then inserted into the measurement socket; the drain-source voltage (V_{ds}) and the gate-source voltage (V_{gs}) are adjusted to obtain the specified bias conditions with the push-button P closed.

With the push-button P open, the bridge is rebalanced, and the values of g_{os} or R_e (y_{os}) and I_m (Y_{os}), if needed, are then read.

9.3.5 Specified conditions

- Drain-source voltage
- Gate-source voltage or drain current
- Frequency of measurement.

9.4 Two voltmeter method

9.4.1 Circuit diagram

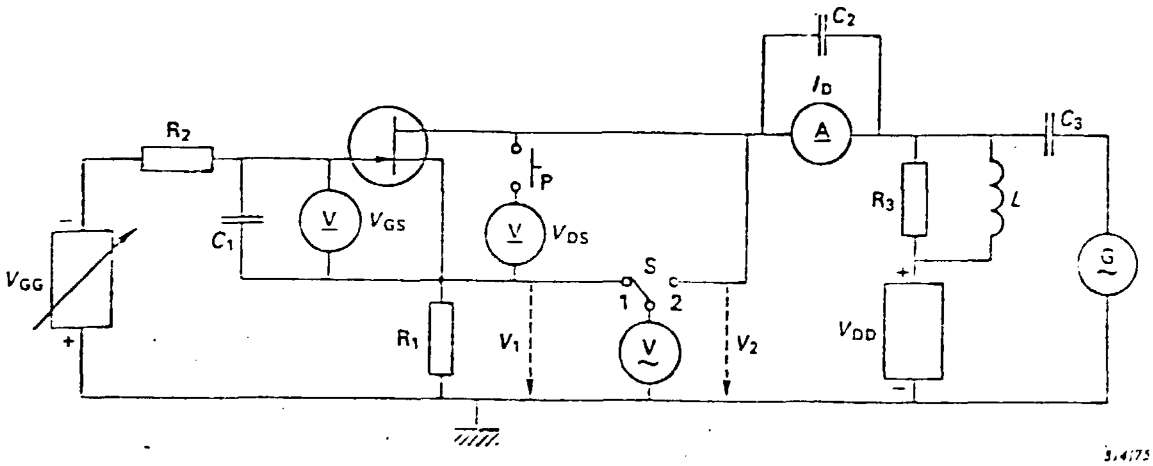


Fig. 7 - Basic circuit for the measurement of the output conductance g_{os} (two-voltmeter method).

9.4.2 Circuit description and requirements

All bias voltages applied should be adequately decoupled at the frequency of measurement.

The value of C_1 should be much larger than (Y_{is}); the value of C_2 should be high.

Inductance L is optional; its use facilitates the adjustment of the specified operating point.

Resistor R1 should be sufficiently low with respect to $\frac{1}{g_{os}}$; practically, a value of 10 Ω to 100 Ω will be used, in accordance with the voltmeter sensitivity.

The a.c. voltmeter should have sufficient sensitivity; for the measurement of low conductances, it should preferably be a selective instrument.

9.4.3 Precautions to be observed

See 3:47-003.

9.4.4 Measurement procedure

The device to be measured is inserted into the measurement socket; the drain-source voltage (V_{ds}) and the gate-source voltage (V_{gs}) are adjusted to obtain the specified bias conditions with the push-button P closed.

With the switch S in position 1, the value $V_1 = I_d . R_1$ is measured, while with the switch S in position 2, the value V_2 = V + 1 R1 is measured.

$$V_2 - V_1 = V_{ds}$$

$$I_d = \frac{V_1}{R_1}$$

$$\underline{(Y_{os})} = \frac{V_1}{R_1(V_1 - V_1)} \simeq \frac{V_1}{R_1 V_2} \quad (\text{for } V_2 \gg V_1)$$

For sufficiently low frequencies $(Y_{os}) = g_{os}$.

9.4.5 Specified conditions

- drain-source voltage
- gate-source voltage or drain current
- frequency of measurement.

10. SMALL-SIGNAL SHORT-CIRCUIT OUTPUT CAPACITANCE C_{OS} (TYPES A, B AND C)

10.1 Purpose

To measure the small-signal short-circuit output capacitance, under specified conditions.

10.2 General

As mentioned in sub-clauses 9.2 and 9.3.2 the method of sub-clause 9.3 may also be used for the measurement of C_{os}. However, it is often preferable to use a separate method of measurement for Cos, especially when the method of sub-clause 9.4 is used for the measurement of g_{os}.

10.3 Circuit diagrams

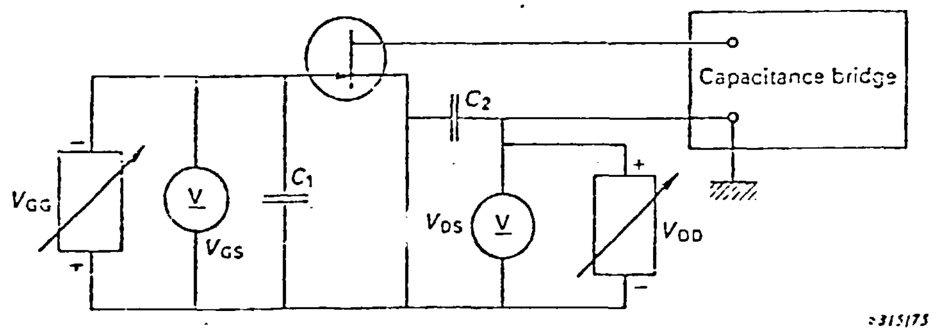


FIG. 8. — Basic circuit for measurement of short-circuit output capacitance C_{os}.

If the capacitance bridge can not (or should not) carry d.c. the alternative circuit shown in Figure 9 should be used.

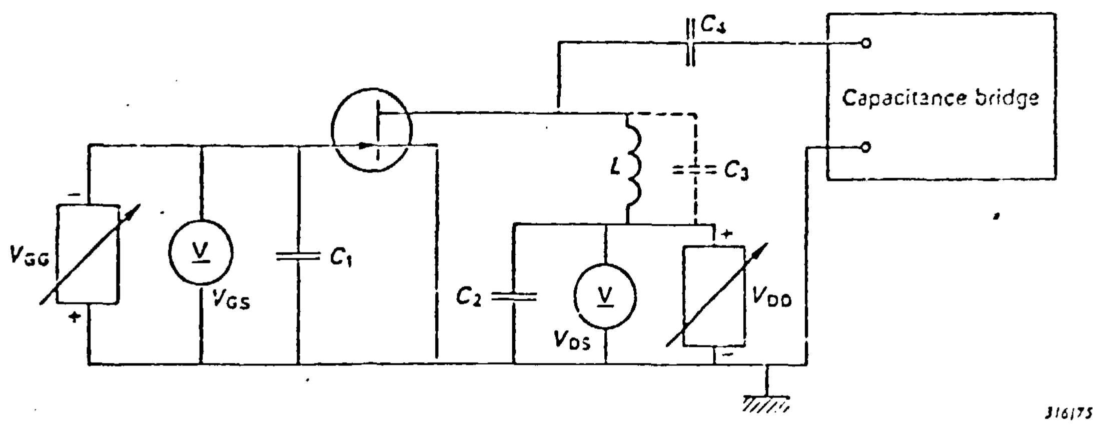


FIG. 9. — Alternative circuit for measurement of short-circuit output capacitance C_{os}.

10.4 Circuit description and requirements

A capacitance bridge is used, thus making it possible to apply a null method. C_2 should be much larger than C_{os} and C_2 much larger than (Y_{is}).

The impedance of L should be sufficiently high, so that it is possible to compensate it by the bridge adjustments. The d.c. resistance should be low compared to the output resistance of the device. Alternatively, a suitable tuned parallel resonant circuit (or at very low drain currents, a suitable resistor) may be used.

10.5 Precautions to be observed

See 3:47-003.

10.6 Measurement procedure

With no device in the measurement socket, the zero adjustment of the capacitance bridge are made.

The device to be measured is then inserted into the measurement socket; V_{ds} and V_{gs} (or I_d) are adjusted to the specified values.

The bridge is rebalanced; the difference of the capacitance readins of this adjustment and that with no device in the measurement socket yields the value of C_{os}.

10.7 Specified conditions

- drain-source voltage
- gate-source voltage or drain current
- frequency of measurement.

11. SMALL-SIGNAL SHORT-CIRCUIT FORWARD TRANSCONDUCTANCE g_{fs} (TYPES A, B AND C)

11.1 Purpose

To measure the small-signal short-circuit forward transconductance, under specified conditions.

11.2 General

Two alternative circuits are described, one using a null method the other using the two voltmeter principle.

- the first method needs a three-pole transfer admittance bridge, but has the advantage that g_{fs} may be measured at low frequencies, as well as $y_{fs} = g_{fs} + jb_{fs}$ at high frequencies. Furthermore, it guarantees a real short-circuit at the output.
- the second method simply measures the modulus of y_{fs} which is identical with g_{fs} for sufficiently low frequencies.

11.3 Null method

11.3.1 Circuit diagram

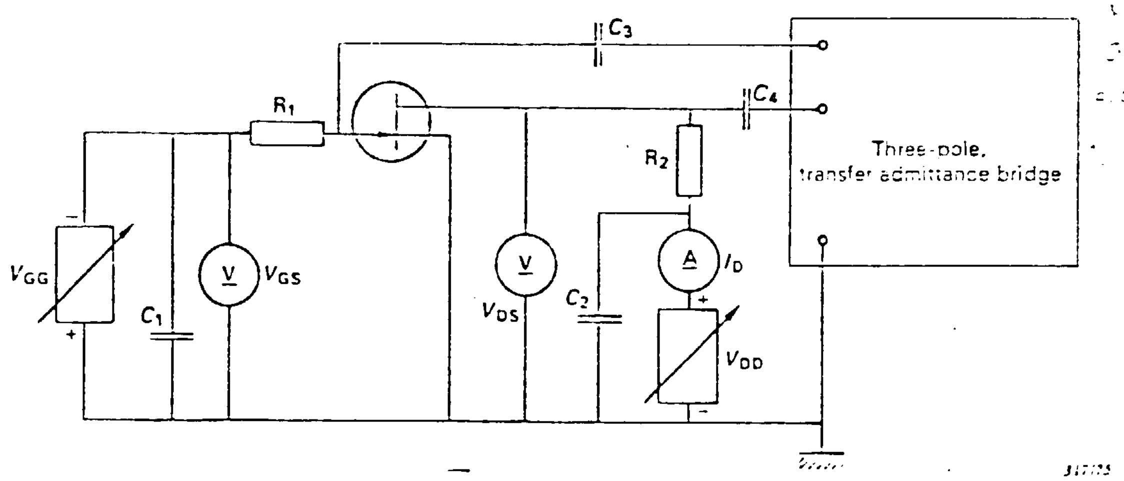


FIG. 10. — Circuit for the measurement of short-circuit forward transconductance, g_{fs}.

11.3.2 Circuit description and requirements

All bias supply voltages applied should be adequately decoupled at the frequency of measurement.

The values of C_1 should be much larger than (Y_{is}) and the value of C_2 should be much larger than (Y_{os}).

R_1 should be much larger than the internal impedance of the bridge, in order not to affect the measurement accuracy.

R_2 should be much larger than the internal resistance of the detector, but nevertheless sufficiently lower than $1/Y_{fs}$, in order not to affect the measurement sensitivity.

The values of C_3 and C_4 should be much larger than (Y_{fs}) to be measured.

The internal resistance of the voltmeter V_{ds} should be much larger than V_{ds}/I_d.

11.3.3 Precautions to be observed

See general precautions.

11.3.4 Measurement procedure

With no device in the measurement socket, the zero adjustments of the bridge are made.

The device to be measured is then inserted into the measurement socket; V_{ds} and V_{gs} (or I_d) are adjusted to the specified values.

The bridge is rebalanced, and the values of g_{fs}, or R_e (Y_{fs}) and I_m (Y_{fs}) if needed, are then read.

11.3.5 Specified conditions

- drain-source voltage
- gate-source voltage or drain current
- frequency of measurement.

11.4 Two-voltmeter method

11.4.1 Circuit diagram

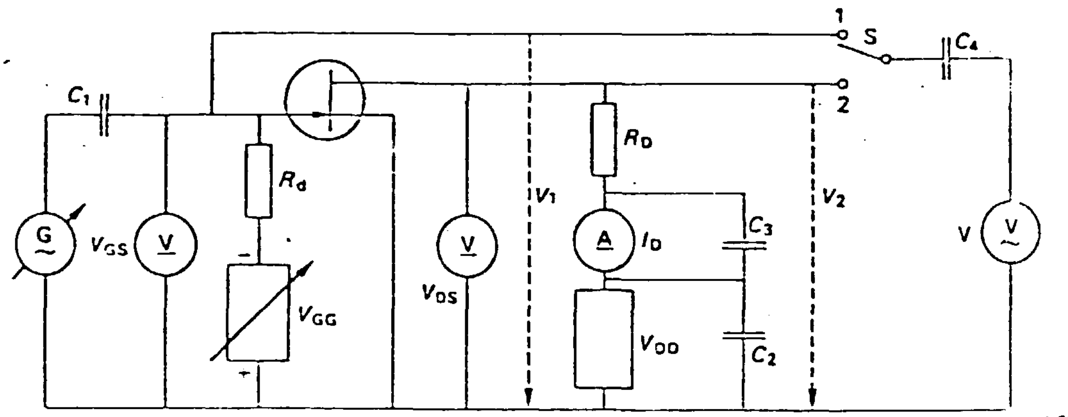


FIG. 11. — Circuit for the measurement of forward transconductance g_{fs} (two-voltmeter method).

11.4.2 Circuit description and requirements

A suitable oscillator should be used, the frequency of which should be sufficiently low.

The values of C_1 and C_2 should be much greater that $1/R_d$. The value of C_1 should be high.

The value of resistor R_g is not critical; it should preferably not be too high.

Resistance R_d must be low compared with $\left| \frac{1}{Y_{os}} \right|$.

Voltmeter V (see figure 11) should have sufficient sensitivity; for the measurement of low values of g_{fs}; it should preferably be a selective instrument.

11.4.3 Precautions to be observed

See general precautions Doc. 3:47-003.

11.4.4 Measurement procedure

The device to be measured is inserted into the measurement socket: V_{ds} and V_{gs} (or I_d) are adjusted to the specified values.

With the switch S in position 1, the value $V_1 = V_{gs}$ is measured while with the switch S in position 2, the value

$V_2 = V_{ds} = I_d \cdot R_d$ is measured.

Thus:

$$Y_{fs} \quad \frac{I_d}{V_{gs}} = \frac{V_2}{V_1 \cdot R_d}$$

For sufficiently low frequencies: Y_{fs} g_{fs}.

11.4.5 Specified conditions

- drain-source voltage
- gate-source voltage or drain current
- frequency of measurement.

12. SMALL-SIGNAL SHORT-CIRCUIT FEEDBACK CAPACITANCE C (TYPES A, B AND C)

12.1 Purpose

To measure the small-signal short-circuit feedback capacitance, under specified conditions.

12.2 Circuit diagram

12.2.1 Figure 12 shows an example of the circuit to be used. A differential transformer bridge is used.

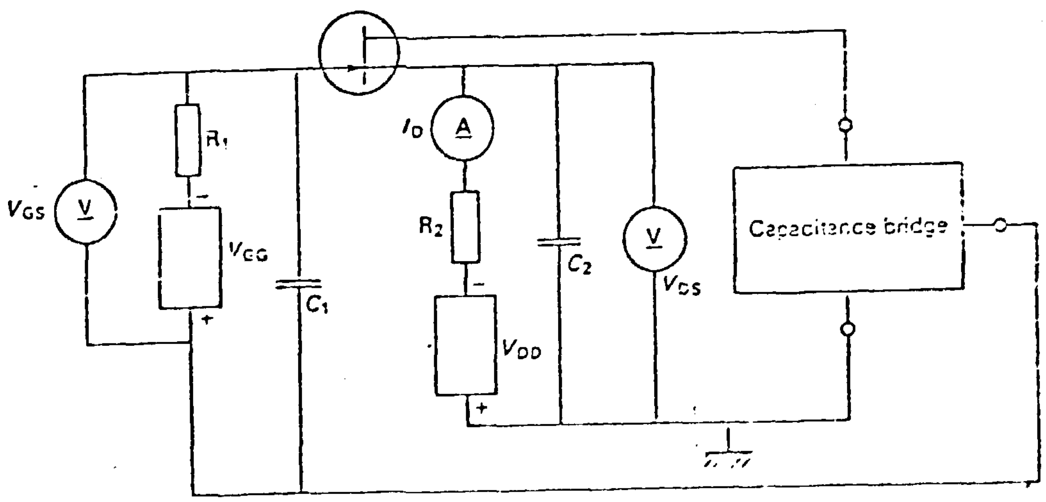


FIG. 12. — Circuit for measurement of feedback capacitance C..

12.2.2 If the bridge can not (or should not) pass d.c., the alternative circuit shown in figure 13 should be used.

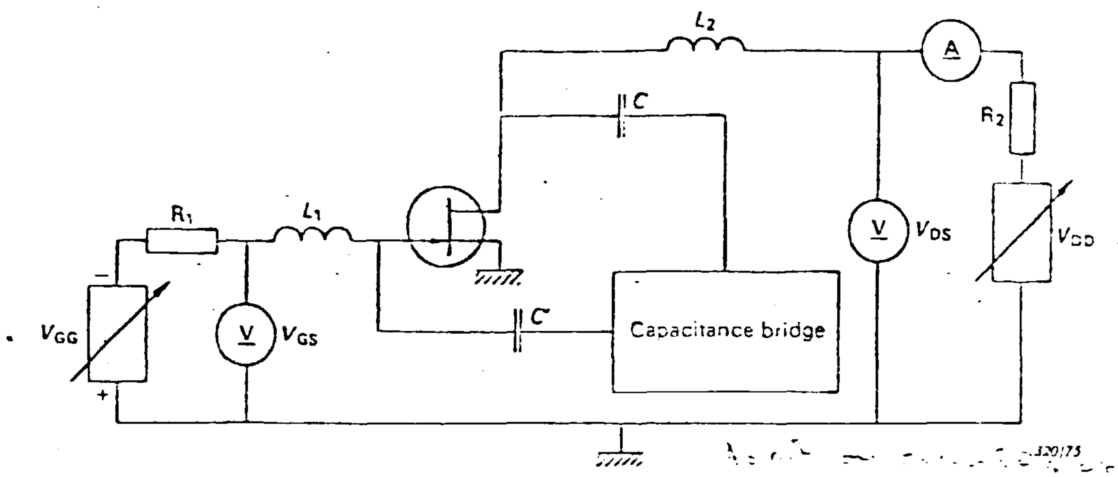


FIG. 13. — Circuit for measurement of feedback capacitance C_n (when the bridge cannot pass d.c.).

Equivalent circuit

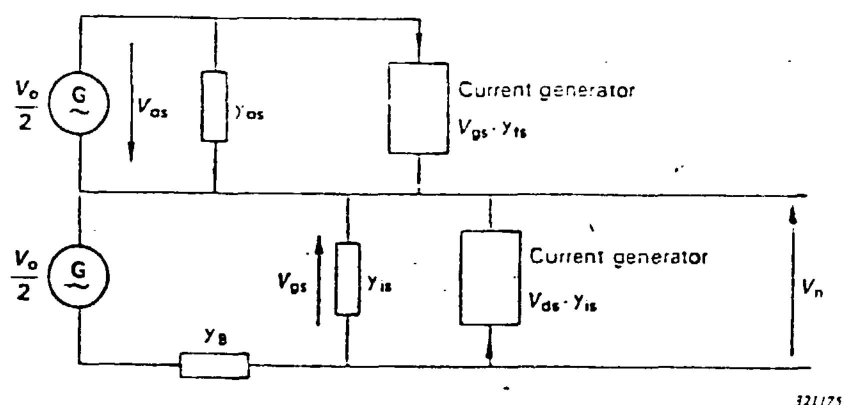


FIG. 14. — Equivalent circuit.

Evaluation of the equivalent circuit for $V_n = 0$ yields:

$$Y_n = Y_b$$

12.3 Circuit description and requirements

Capacitances: C_1 should be much larger that (Y_{is}) and C_2 much larger that (Y_{os}).

Resistor R_2: the value of this resistor should not be too high. It may be preferably to shunt it by an adequate inductance L.

12.4 Precautions to be observed

See general precautions.

12.5 Measurement procedure

With no device in the measurement socket, the bridge is initially balanced.

The device is inserted into the measurement socket and the operating point adjusted to the specified values V_{ds} and V_{gs} (or I_d).

The bridge is again adjusted for balance. The reading of Y_b for this adjustment minus the reading of the initial adjustment yields: $Y_d = g_d + j\ C_d$.

12.6 Specified conditions

- drain-source voltage
- gate source voltage or drain current
- frequency of measurement.

13. NOISE (TYPES A, B AND C)

13.1 Purpose

To measure the equivalent input noise voltage or noise factor, under specified conditions.

13.2 Equivalent input noise voltage

13.2.1 Circuit diagram

A circuit in accordance with the block diagram shown in Figure 15 should be used.

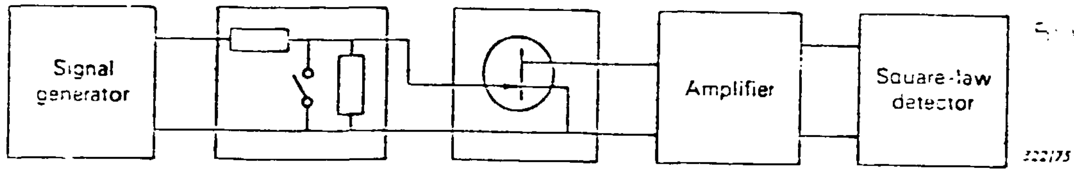
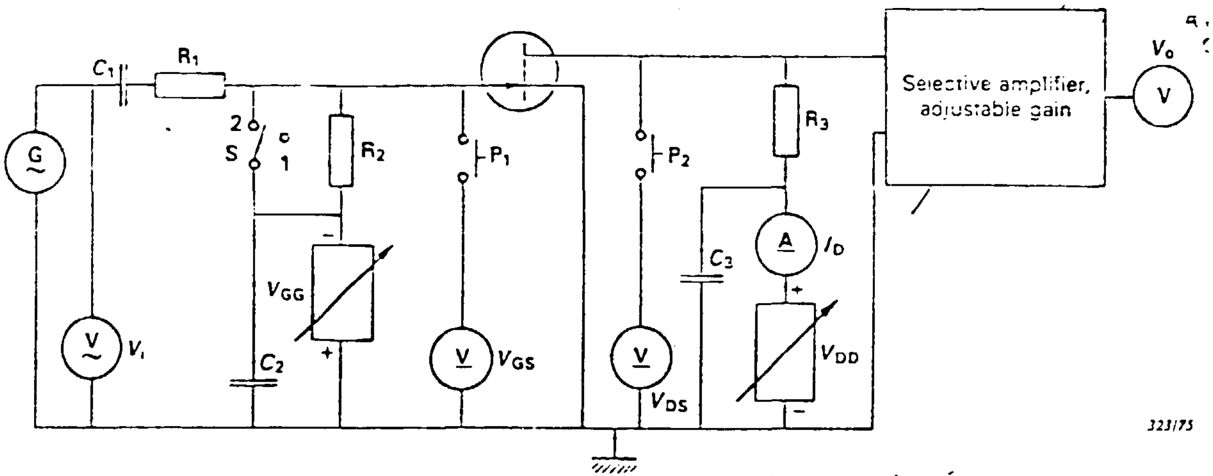


FIG. 15. — Block diagram for the measurement of equivalent input noise voltage.

Figure 16 shows an example of a circuit in accordance with that block diagram.



P_1, P_2 = push-buttons

FIG. 16. — Circuit for the measurement of equivalent input noise voltage.

13.2.2 Circuit description and requirements

The frequency of the generator should be adjusted to be the centre frequency of the selective amplifier. The output voltage should be adjusted in such a way that the input voltage to the transistor is high compared with the noise voltage, but low enough to avoid overloading of the device.

The voltage dividing ratio of the voltage divider (R2.Rl) should be known.

For the bias source, special care should be taken to achieve low noise biasing (especially important for the gate bias).

All resistors that might deliver noise to the circuit should be of a low-noise type (e.g. metallic film resistors).

A neutralization network should be used, when appropriate.

Adequate shielding to minimize the influence of external electromagnetic fields should be provided, when appropriate.

The amplifier should be linear up to a level of at least 20 dB higher than the r.m.s. noise value, so that noise peaks are correctly amplified.

The second stage noise should be as low as possible. The noise level measured with the device removed from the circuit should be at least 15 dB lower than that measured with the device in the circuit.

The output voltmeter should measure the true r.m.s. value.

The equivalent noise banwidth should be accurately known.

C_3 should be much larger than $1/R_3$ and C_2 much larger than 1/R2.

13.2.3 Precautions to be observed

See Doc.: 3:47-003.

13.2.4 Measurement procedure

The device is inserted into the measurement socket and the operating point is adjusted to the specified values of V_{ds} and V_{gs} (or I_d).

The input voltage V_1 is adjusted to a suitable value (e.g. 0,1V).

With switch S in postion 1, the output voltage V_{01} is measured, after proper adjustment (of the grain of the amplifier.

With switch S in position 2, the output voltage V_{02} is measured.

The noise voltage is given by:

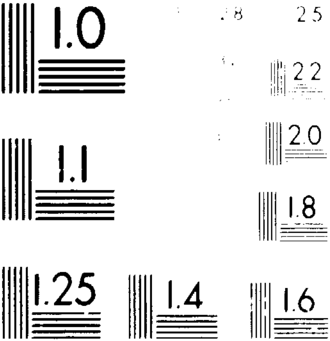
$$V_n = \frac{V_{02}}{V_{01}} V_i \frac{R_2}{R_1 + R_2}$$

13.2.5 Specified conditions

- ambient or reference point temperature
- values of resistors R_1 and R_2
- drain-source voltage
- gate-source voltage or drain current
- frequency of measurement and bandwidth.

13.2 Noise figure

All methods of measurement for bipolar transistor (see Doc.: 3:01.47.1-010) are applicable for field-effect transistors.


1.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

13.4 Relation between equivalent input noise voltage and noise factor

If a resistor R_g is inserted between the input terminals, the overall noise voltage is given by:

$$Vn_{(o)} = \sqrt{Vn^2 + 4KTR_g \Delta f}$$

From this, the general formula for the noise factor yields:

$$F = \sqrt{\frac{Vn^2 + 4KTRg \Delta f}{4KTR_g \Delta f}}$$

The formula for $Vn_{(o)}$ yields a possibility for measuring Vn directly.

The generator is disconnected from the circuit and R2 is replaced by a variable resistor Rg. With Rg short-circuited, the resulting output voltage is measured. The short-circuit is then removed and Rg is adjusted to yield an output voltage twice higher.

Then: $Vn = \sqrt{4KTR_g \Delta f}$

14. Y-PARAMETERS (TYPES A, B AND C)

Some of the low frequency and intermediate frequency y-parameters can be measured, as indicated in this publication. For the y-parameters for high frequency, all methods of measurement for bipolar transistors (see Doc. 3:1.47-010) are applicable for field-effect transistors.

15. SWITCHING TIMES (TYPE A, B AND C)

15.1 Purpose

To measure the various switching times, under specified conditions.

15.2 General

As a rule, the turn-on time (t_{on}) and the turn-off time (t_{off}) should be measured as the switching times. Unless otherwise specified, the common-source configuration is used.

15.3 Circuit diagram

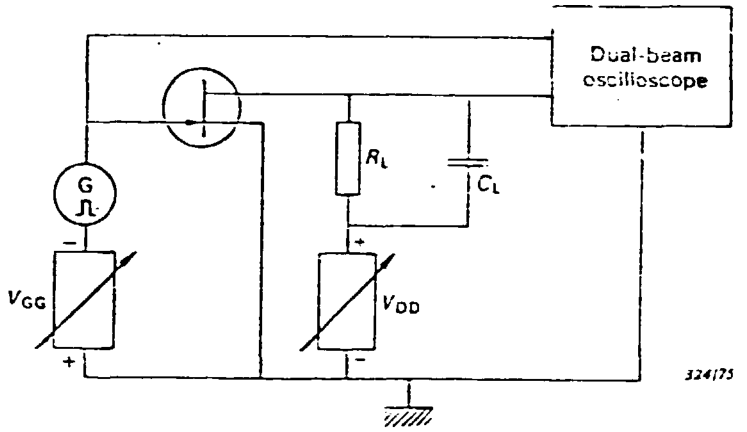


FIG. 17. — Circuit for measurement of switching times.

15.4 Circuit description and requirements

The internal resistance of the bias supply Vgg should be smaller than 0.01 Rg. Where Rg is the equivalent internal resistance of the pulse generator. The internal resistance of the bias supply V_{dd} should be smaller thant 0.01 R_L.

The pulse with of the pulse generator should be much greater than the turn-on and the turn-off times of the device to be measured: the duty cycle should be low (about 1%).

The rise and fall times of the pulse should be less than 0.25 of the rise and fall times of the device to be measured.

A double-beam oscilloscope should be used: its rise time should be less than 0.25 of the rise time of the device to be measured.

15.5 Precautions to be observed

See general precautions.

15.6 Measurement procedure

The device to be measured is inserted into the measurement socket. The voltages V_{gg} and V_{dd} are adjusted to the specified values.

The specified input voltage V_p is applied by means of the pulse generator.

The input and output waveforms are displayed on the oscilloscope and the turn-on and the turn-off times are measured in accordance with Figure 18.

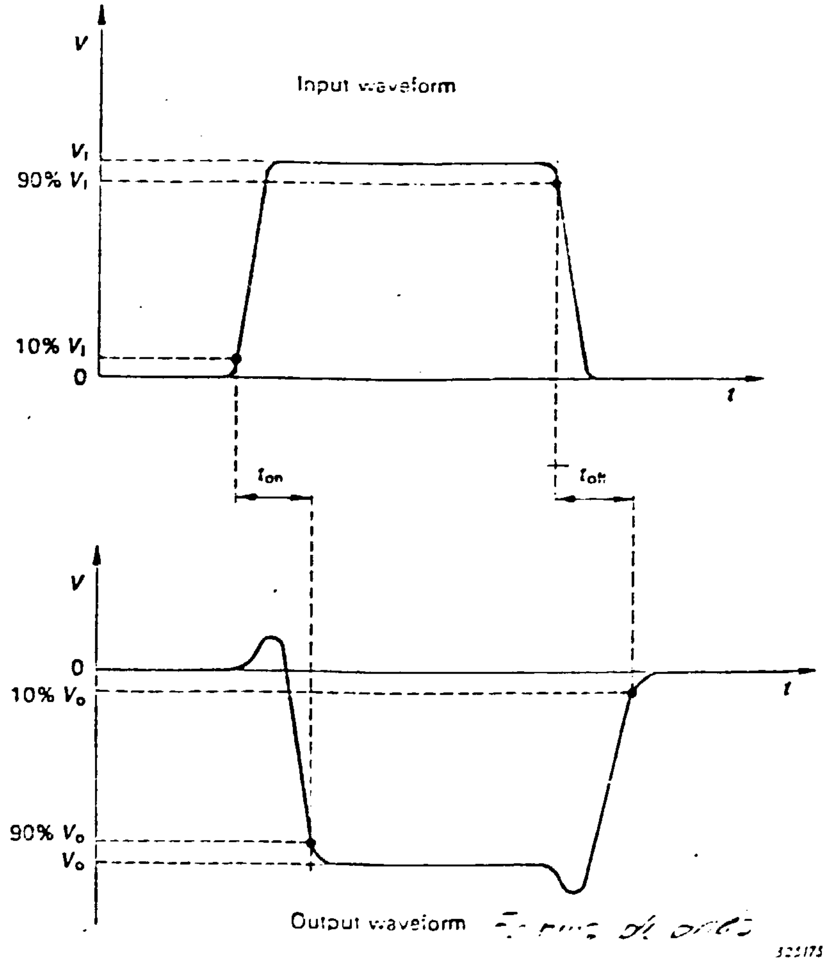


FIG. 18. — Waveforms in the measurement of switching times.

15.7 Specified conditions

- ambient or reference point temperature
- supply voltages
- values of R_L and C_L
- input pulse conditions:
  . amplitude,
  . duration,
  . repetition frequency,
  . rise and fall times.

16. STATIC DRAIN-SOURCE ON-STATE RESISTANCE $R_{ds\ on}$ OR DRAIN SOURCE ON-STATE VOLTAGE $V_{ds\ on}$ AND OFF-STATE RESISTANCE $R_{ds\ off}$

16.1 Purpose

To measure drain-source on-state resistance or drain-source on-state voltage" and "off-state resistance" under specified conditions.

16.2 General

As a rule, $r_{ds\ on}$ and $r_{ds\ off}$ are expressed in terms of d.c. resistance under conditions of saturation and cut-off respectively, as shown in Figure 19. Unless otherwise specified, the common-source configuration is used.

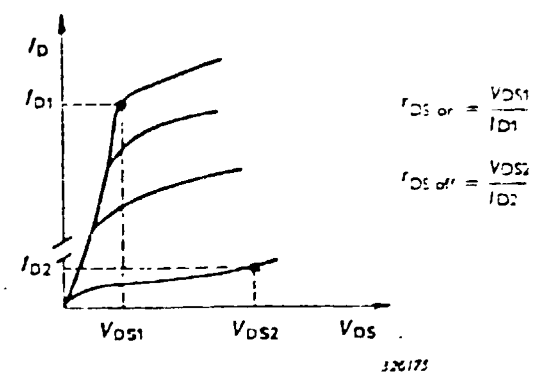


FIGURE 19

16.3 Circuit diagram

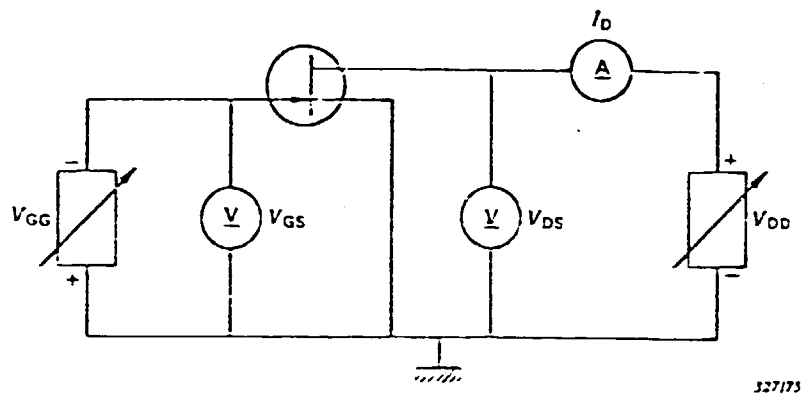


FIG. 20. — Circuit of measurement for on-state and off-state resistances.

16.4 Circuit description and requirements

The internal resistance of the voltmeter should be much higher than the on-state and off-state resistances to be measured.

16.5 Precautions to be observed

See general precautions.

16.6 Measurement procedure

16.6.1 On-state and off-state resistances

The device to be measured is inserted into the measurement socket; V_{ps} and Vgs are adjusted to the specified values.

The drain current I_p is measured, and the on-state and off-state resistances are calculated by means of the following equations:

$$r_{ds\ on} = \frac{V_{ds1}}{I_{d1}}$$

$$r_{ds\ off} = \frac{V_{ds2}}{I_{d2}}$$

16.6.2 Drain-source on-state voltage

The device to be measured is inserted into the measurement socket; V_{gs} and I_d are adjusted to the specified values.

The measured value of V_{ds} is then the required value of the on-state voltage.

16.7 Specified conditions

- ambient or reference point temperature
- drain-source voltage or drain current
- gate-source voltage.

17. ON-STATE DRAIN-SOURCE RESISTANCE (UNDER SMALL-SIGNAL CONDITIONS)

17.1 Purpose

To measure the on-state drain-source resistance, by means of a low-frequency bridge.

17.2 Circuit diagram

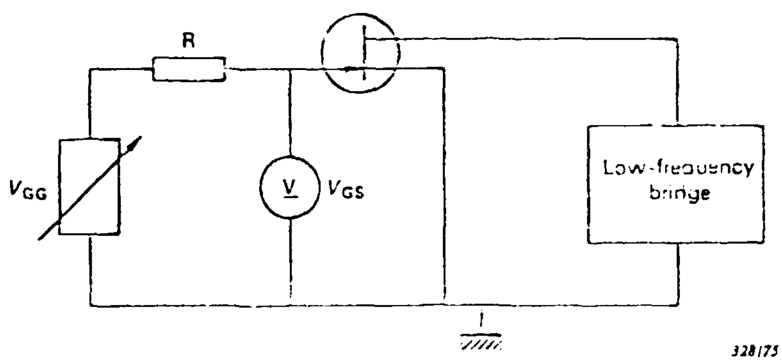


FIGURE 21

17.3 Circuit description and requirements

The bridge should be able to pass d.c.

For type B and C devices, the case and/or substrate should be connected to the source.

17.4 Precautions to be observed

See general precautions.

17.5 Measurement procedure

The bridge is first balanced without the transistor. The transistor is then inserted into the measurement socket and the gate-source voltage is adjusted to the specified value. The bridge is rebalanced, and the value of the on-state resistance is read from the bridge.

17.6 Specified conditions

- drain-source voltage (equal to zero)
- gate-source voltage
- frequency (1kHz, unless otherwise specified).

Note: The bridge may be replaced by an a.c. voltmeter, a.c. ammeter and signal generator, if desired.

ANNEX V

QUALITY ASSESSMENT SYSTEM FOR ELECTRONIC COMPONENTS

0. INTRODUCTION

0.1 Realizing the importance of quality and reliability for electronic equipment, specially meant for professional applications in the expanding sectors of telecommunications, defence, avionics, space research, nuclear instrumentation, etc., the British government and British Electronics Industry sponsored a quality assessment system for electronic components in 1966. This concept spread to other countries in Europe and in 1970, under the auspices of the European Committee for Electrotechnical Standardization (CENELEC), the CECC system came into being. This European system for quality assessment for electronic components is giving place to an international system for quality assessment for electronic components under the aegis of the International Electrotechnical Commission.

0.2 The International System for Quality Assessment for electronic components is being set up, with several arrangements being made by the prospective participants of the system. The participants now include 21 countries, most of the developed countries and a few developing countries. The participants are from Western Europe, USSR, Poland and Hungary from centrally planned economies, Japan and South Korea from the far east, USA, Australia, India, China and Israel.

0.3 In the context of Brazil being an important producer of electronic components and considerable portion of the manufacture being exported, the need for evolution of a national system of quality assessment for electronic components, was highlighted in the First Brazilian Seminar on Standardization in Electronics held at São José dos Campos in June 1979. One of the components factories in Brazil, due to absence of a national system for quality assessment, has made bilateral arrangements with two foreign customers for capability approval, in respect of the range of electronic components being manufactured. This report ..s presented on the need for planning a quality assessment system for electronic components at national level, with a view to enrolling itself at a later date for affiliation with the International System.

0.4 This report is presented in two parts as follows:

Part I - Description of quality assessment system for electronic components as practised at national and international levels.

Part II - Prospects and recommendations for planning for a similar system in Brazil.

PART I

DESCRIPTION OF QUALITY ASSESSMENT SYSTEM FOR ELECTRONIC COMPONENTS

1. PRINCIPLES OF THE SYSTEM

1.1 The system is intended to provide a "comprehensive arrangements for the specification and quality assurance of electronic components". It is expected to:

- meet the needs for assured performance and quality of electronic components
- give a greater degree of confidence of quality and value to the manufacturers and users of

of electronic equipment

- give a lower equipment <u>life cost</u> due to a higher order or reliability.

1.2 The system provides an integrated service of standards development and implementation. In the case of electronic components manufacture, it is not uncommon to find a manufacturer keeping a number of capability approvals (certification of process capability) by different purchasers. In one of the components factories in Brazil, the factory is maintaining capability approvals from two different foreign customers in order to export its components. If there is a national system for quality assessment with international approval, it is possible that such a manufacturer need not seek capability approvals by different customers.

2. ADVANTAGES OF THE SYSTEM

2.1 The advantages of the system to the component users (equipment manufacturers) and the equipment users are:

- a controlled procedure of quality assurance known to the customer, which reduces his inspection costs
- easier interchangeability of suppliers
- a product of known consistent quality levels, in general at a minimal increase in costs
- winning the reputation for quality at international market.

3. DETAILS OF THE SYSTEM

3.1 The system at national level will consist of:

- a <u>National Authorized Institution</u>, to manage the system at a national level
- a <u>National Standards Organization</u>, which prepares and issues national standards
- a <u>National Supervising Inspectorate</u> for supervision of testing and inspection of the system supported by a recognized calibration service for verification of measurement standards.

3.1.1 These can be in a single or more entities in a country.

3.2 <u>National Authorized Institution (NAI)</u>

This is normally the national institution entrusted with the responsibility for promotion and implementation of industrial quality, with necessary resources for managing the system. This establishes the "Rules of Procedure" of the system.

3.3 <u>National Standards Organization (NSO)</u>

This is normally the national standards organization with the responsibility for development and publication of national standards in the electronic field, having collaboration at the international level with the International Electrotechnical Commission. This organization establishes various standard specifications.

3.4 <u>National Supervising Inspectorate (NSI)</u>

It provides an independent service for surveillance of the manufacturers, including inspection and testing. The recognized calibration service of the country provides the required verification of measurement standards of the manufacturers and testing laboratories.

3.5 Method of Operation

A manufacturer wishing to take part in the system should prove to NSI that his inspection and quality assurance departments satisfy the requirements laid down by the "Rules of Procedure" and various specifications, and that his manufacturing procedures are adequately controlled.

3.5.1 If the manufacturers are using certain test facilities in independent test laboratories, they shall also be accredited for the purpose by NAI.

3.5.2 To obtain approval for a component, the manufacturer should demonstrate that specimens taken from the production line meet the test requirements prescribed in the relevant specifications. Testing is done under the surveillance of NSI either in the manufacturer's own laboratories or in an accredited test laboratory. When approval has been obtained, the name of the manufacturer and the approved product will be registered in a national register known as Qualified Products List (QPL) maintained by NAI.

3.5.3 Electronic components covered under a national system of quality assessment, are continuously monitored by means of a four stage inspection programme. Samples are randomly selected from each inspection lot using the sampling procedures laid down in a national standard equivalent to IEC 410, and subjected to testing. This testing is divided into lot-by-lot and periodic.

The lot-by-lot inspection is completed before a given lot is released and it is sub-divided into:

Group A - Visual inspection and short duration electrical and mechanical tests which are normally non-destructive.

Group B - Electrical, mechanical and environmental tests which may take up to one week to complete. Some of these may be "destructive" and the component after tests can not be released to a customer.

The periodic inspection is normally sub-divided into:

Group C - Tests of longer duration than the lot-by-lot tests, such as mechanical and electrical endurance tests or the longer environmental tests. These are usually at three-monthly intervals. Specimens from the Group C tests may be collected from the lots which have passed Groups A and B tests during the three month period or they may be taken from a lot which has passed Groups A and B inspection at the end of the three month period. For these periodic tests, fixed sample sizes are sometimes used, instead of a sample size dictated by an inspection level and Acceptable Quality Level (AQL).

Group D - Tests which need to be repeated only at long intervals of one, two or three years.

Each of the Groups A to D may be divided into sub-groups for convenience in arranging the tests and in sampling at the appropriate levels.

3.6 Capability Approval

Experience has shown that the method of operation given in 3.5 is essentially for components made in continuous production runs (e.g. capacitors, resistors, ferrites, potentiometers, etc.). Where components are made by a common process but vary in detail to meet individual customer requirements, the system has to be modified to accommodate this requirement by what is termed capability approval. This is limited to certain types of component (e.g. printed circuit boards, transformers and custom-built integrated circuits).

3.6.1 A manufacturer seeking approval under these arrangements has to prepare a capability manual which:

- defines his capability in terms of tolerance limits
- declares design constraints which are essential to the maintenance of quality
- describes suitable test programmes to demonstrate that he can achieve his declared capability.

Lot-by-lot and periodic tests are made on representative production specimens to verify the quality conformance of his stated capability.

3.6.2 The study commission decides when developing the specifications which procedure shall be used in any component family or sub-family.

3.7 Certified Test Records (CTRs)

A certified test record is an important document in the system. Where it is prescribed in a detail specification, the results from certain groups or sub-groups of the inspection schedule, especially endurance tests, are kept by the manufacturer in a clear and standardized form for study by a customer or potential customer. The results for periods of six months spread over a time interval of three years, are given as number of items tested and number of defectives. Manufacturers of equipments (customers for components) verify the information in order to ascertain the consistency of a particular manufacturer's product.

3.8 Approval

A manufacturer wishing to take part in the system and have his product entered in the Qualified Products List (QPL) (see also 3.5.2), should have approval from the National Authorized Institution.

3.8.1 The system works on the principles of self-certification. When the manufacturer has received his approval for his components, he is authorized to release the components, accompanied by a certificate of conformity. The manufacturer in releasing the components to his customer makes a declaration that he has performed all the lot-by-lot inspection scheduled in the detail specifications and that the components have fulfilled the performance requirements prescribed. He keeps records of his lot-by-lot and periodic inspection including the certified test records (see 3.7) for future verification, when required.

3.9 Specification system

3.9.1 In order to operate a quality assessment system, it is necessary to streamline all the relevant standards in a specification system according to IEC Guide 102 which consists of

- basic specifications
- generic specifications
- sectional specifications where appropriate
- blank detail specifications
- detail specifications.

3.9.2 Basic Specifications - are applicable to the whole system. This defines:

- main principles of the system
- main working procedures for administrative matters of the system (Ref.: IEC QC 001001
IEC QC 001002 Part 1)
IEC QC 001002 Part 2).

These also include other standards covering, for example, environmental testing and sampling procedures.

3.9.3 Generic Specifications - relate to a family of components, e.g. fixed resistors, semiconductor devices. They contain the terms, definitions, test methods, standard values for characteristics and information relating to the quality assessment procedures. (Ref. IEC QC 300000 - Fixed capacitors for use in electronic equipment - Part 1 Generic specification).

3.9.4 Sectional Specifications - When required, relate to a sub-family of components, e.g. tantalum capacitors with non-solid or solid electrolyte. They are prepared when a substantial amount of information is peculiar to a particular sub-family. (Ref.: IECQC 300200 - Fixed capacitors for use in electronic equipment. Part 15 - Sectional specification: Fixed tantalum capacitors with non-solid or solid electrolyte).

3.9.5 Blank detail specifications - are proforma documents derived from the requirements of the generic and sectional specifications, which when completed by the specification writer in accordance with the specific requirements for a particular component become the detail specification for that component. (Ref.: IEC QC 300401 - Fixed capacitors for use in electronic equipment - Part 2: Blank detail specification: Fixed metallized polyethylene terephthalate film dielectric d.c. capacitors).

3.9.6 Detail specifications - are prepared by completing the information given in an existing blank detail specification or in accordance with the rules for the preparation of detail specifications given in the generic or sectional specification where no blank detail specification exists. (Ref.: BS: 9522 (N0001) detail specification for multi-contact circular electrical connectors for frequencies below 3 MHz. Bayonet coupling with front release, rear removable crimp contacts).

4. INTERNATIONAL ELECTROTECHNICAL COMMISSION QUALITY ASSESSMENT SYSTEM (IECQA)

4.1 This system operates in compliance with the statutes of and under the authority of IEC. Its object is to facilitate international trade in electronic components of assessed quality. This is achieved by the definition and implementation of quality assessment procedures in such a manner that components released in one participating country, as conforming to the requirements of an applicable specification, are equally acceptable in all other participating countries without the need for further testing.

4.2 Field of operation

The system can be made applicable to all electronic components for which quality assessment is required and appropriate.

4.3 International Organization

The international organization operating under the auspices of the IEC council, consists of:

- the Certification Management Committee for electronic components (CMC) which manages the system
- the Inspection Co-ordination Committee (ICC) which approves the National Supervising Inspectorates (see 4.4) and the uniform application by them of the rules of procedure concerning quality assessment and certification.

4.4 National Organization

The national organization of participating countries of the system consists of:

- a National Authorized Institution, to manage the system at a national level

- a National Standards Organization, to prepare and issue standards
- a National Supervising Inspectorate (NSI) to test and carry out inspections under the system supported by one or more recognized calibration services for verification of measurement standard

These can be in a single or more entities in a country.

4.5 Participation

The IECQA system is open to member countries of IEC which have established National Authorized Institutions and National Standards Organizations and which agree to:

- publish and implement the rules of the system in their country
- recognize without discrimination the approvals of manufacturers, including their testing laboratories, independent distributors and independent test laboratories, the qualification approvals of components and the validity of quality conformance inspection of components released in other participating countries according to the system
- to pay the share of the cost of operation of the system by IEC, as the system is to be self-financed and non-profit making*.

4.6 Rules of procedure

The basic rules of IECQC is contained in the following publications:

- IECQC 001001
- IECQC 001002 - Section 1
- IECQC 001002 - Section 2.

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*This cost is to cover the cost of the secretariat of the Certificatic Management and Inspection co-ordination committees of IEC, as all the countries are not benefited by this system.

4.7 Status of participation

At present, there are 21 participants. They being:

Developed Countries: Australia, Belgium, Denmark, France, Germany, Hungary, Ireland, Italy, Japan, Netherlands, Norway, Poland, Sweden, Switzerland, U.K., USSR, USA.

Developing Countries: China, India, Israel and Republic of Korea.

4.8 Cost of operation

The budgeted expenditure for IEC to manage the system is SwFr 162.000 for 1984 and the subscription for countries of comparable status to Brazil (in terms of proprotionate cost of sharing IEC expenses) is SwFr3.904 only.

PART II

PROSPECTS AND RECOMMENDATIONS FOR A SIMILAR SYSTEM IN BRAZIL

5. PROSPECTS

5.1 It is estimated that Brazil caters to a demand of over 3 billion US dollars worth of electronic equipment and components and the electronic components are exported to several countries (see also 0.3). In one of the factories which exports about 40 percent of its production of electronic components, it has quality assessment (capability approval) by two important customers from USA, as a pre-condition for exporting its products. This factory maintains a good inspection system with its own test facilities, to cater to the requirements of its quality assessment system. Another factory, it is reported, is interested in the coverage by a quality assessment system.

5.2 Brazil ranks equally with the following countries, as adjudged from its international trade in the electro technical field:

- Denmark
- Hungary
- Israel
- Korea
- Norway
- Poland.

These countries are already members of the IECQA system.

5.3 The developing countries like China, India, Republic of Korea, Israel have already joined the IECQC system.

5.4 In view of these facts and considering that the additional cost involved will be only SwFr 3.904, when Brazil is already subscribing SwFr 82.730 (for 1984), (an addition of 4 percent only), this country can join the system and get into the main stream of the international electronic components standardization system.

5.5 The immediate advantages are:

- to get to know the international trends in this field
- to get all publications relating to the certification management committee, inspection co-ordination committee, etc.
- to get opportunity to attend all meetings of IECQA and be a member of certification management committee and inspection teams.

5.6 <u>Long-range objective</u>

After preparing the country through an organized national system, Brazil can undertake quality assessment for electronic components under IECQA in the near future. When that stage is reached, manufacturers need not seek bilateral capability approval from the foreign buyers of electronic components, as exists today (see 5.1).

Furthermore, the development of a highly quality conscious electronic components industry is considered essential for self-sufficiency in the matter of defence electronics (Guerra Eletronica). In all countries, preparing for a sound and well-established electronics industry is considered a strategic step for self-sufficiency in respect of modern defence needs.

6. RECOMMENDATIONS

6.1 In organizing the system for quality assessment for electronic components, as described in 3.1, the following components are to be identified:

- National Authorized Institution
- National Standards Organization
- National Supervising Inspectorate.

These are discussed in the subsequent paragraphs.

6.2 <u>National Authorized Institution</u>

INMETRO, which is the executive agency of the System of Standardization, Metrology and Industrial Quality (SINMETRO), fulfills the requirements of a <u>National Authorized Institution</u> to manage the system at the national level. The staff of this organization needs augmention and adequate training. "Rules of Procedure" be elaborated for this purpose.

6.3 National Standards Organization

INMETRO could nominate the Brazilian National Committee for International Electrotechnical Commission (IEC) which is COBEI (Brazilian Committee for Electrotechnical Industry) under the Brazilian Association for Technical Standards (ABNT) for this purpose. This committee has a sub-committee known as CB 3:1 Electronics which has six technical technical commissions dealing with electronic components. There are about 156 standards and the current four year programme envisages addition of about 50 standards. There are a large number of standards which require revision and updating. The details of the existing status of standardization in the field of electronic component is covered in a separate report. For accelerating the status of standards development and streamlining with the unified system of standards for electronic components, as described in 3.9 of this report, the secretariat of COBEI needs augmentation of resources and the technical commissions need adequate and capable secretariat assistance. This could be fairly achieved by strengthening and activating the membership of INMETRO officers of Electrotechnics-electronics department with ABNT technical/study commissions. They may also require training for developing standards, following up developments taking place with IECQC system in respect of standards preparation, updating and constantly briefing the technical commissions for accelerating the pace of development of standards.

6.4 National Supervising Inspectorate

It was observed that the Electronics Division of the Centre for Aerospace Technology (CTA) situated near São Paulo, which is the concentration centre for electronics industries in the country, has an infra-structure for climatic/environmental testing of electronic components, testing of electrical parameters for capacitors and resistors. There are somewhat scattered but not comprehensive facilities for testing certain properties of electronic components in laboratories associated with Research and Technology Institute of São Paulo (IPT), Telecommunications Organization of Brazil (TELEBRAS), Electrical Department of University of São Paulo and laboratories of the defence ministry. However, it is felt that the Centre for Aerospace Technology (CTA), with additional marginal equipment could be the National Supervising Inspectorate (NSI). This being a long and capital-intensive proposal it is recommended that INMETRO may request the Centre for Aerospace Technology (CTA) through appropriate channels, to develop itself into an organization capable of discharging the responsibilities of a national supervising inspectorate under the system. It is further understood that the government has already decided to strengthen the Centre for Aerospace Technology (CTA) to elevate it to a centre for advanced testing and research in the field of electronics to serve the defence needs (Centro de Guerra Eletronica). Therefore, there will be little difficulty in planning for this activity also at CTA. Unless the centre is developed into one of excellence in the matter of testing electronic components and an organization capable of providing services in respect of inspection and testing, the national system can not win the confidence and acceptability from the component manufacturers, who would like the set-up recognized by the international organization (IEC).

6.6 Calibration services

In order to provide measurement assurance for the tests and inspections carried out under the system, the calibration services should be extended and popularized within the test laboratories and manufacturers. For this purpose, a "Guide to calibration system" has been prepared which inter-alia describes the establishment of an effective calibration system which shall be maintained for the control and re-calibration of all measuring standards and measuring equipment. It is further recommended that INMETRO makes a vigorous campaign for selling its metrological services to various electronics industries in the country.

6.7 There is no doubt the development of a system for quality assessment of electronic components needs resources and time. But, Brazil, has to introduce the system in order to compete in the international market from the point of view of reliability and cost. The need for such an action has already been emphasized in the First Brazilian Seminar on Electronic Standardization which was held in 1979, but no action appears to have been taken. It is, therefore, felt that INMETRO has to play a leading role in getting this organized in the country.

ANNEX VI

BASIC TEXT FOR THE DRAFT STANDARD ON GUIDE TO THE USE OF VARIABLE CAPACITORS

FOREWORD

This standard is intended to provide a guide to the methods which should be followed by a designer of an electronic equipment and those handling or using variable capacitors. It is hoped that the precautions provided in this guide will enable the user of variable capacitors to extend the useful and accurate life of the component by ensuring that it is used and handled correctly during the equipment production processes and during the subsequent life of the capacitor.

The variable capacitor is a component which, because of its robust construction, is probably misused and ill-treated more than any other electronic component. It is hoped that the points given below will assist in some measure to maintain performance of variable capacitors by emphasizing some of the many abuses which occur in the use of this component.

This document is based on IEC 612-1978.

1. SCOPE

1.1 This standard deals with the guide for the use of variable capacitors in electronic equipment.

2. PACKAGING AND STORAGE

2.1 During the various stages of packing, unpacking, storage, transportation, and assembly, care should be taken that:

a) for air dielectric capacitors, where the danger exists of fingers or other extraneous touching and damaging the vanes, the rotor vanes are set about the maximum capacitance position;

b) trays of capacitors are not stacked on top of each other in such a way that weight is applied to the capacitors;

c) capacitors are stored in such a way that they can not damage each other and are protected from dust and dirt;

d) storage conditions are preferably the standard atmospheric conditions for testing;

e) in the event of capacitors being returned to the suppliers they are properly packed to prevent damage.

3. MOUNTING AND ASSEMBLY

3.1 Care should be taken to ensure that the capacitor is not mounted on an uneven surface, for this may cause distortion of the frame assembly and a subsequent capacitance change due to variation in the air gaps between rotor and stator vanes. It has been known for example, that the mounting surface is sometimes made uneven by the insertion of connecting wires or perhaps washers under one of the mounting feet. This practice should be avoided.

3.2 If the mounting is suspect, the maximum capacitance (as defined in Doc. 3:01.40.1-039 - Capacitors, Terms and Methods of Test) should be measured before and after mounting in the equipment or test fixture. If any change is detected after mounting, then the method of fixing is suspect and may need modification. By mutual agreement between user and supplier a small change may be tolerated provided that the test fixtures used by them are identical.

3.3 When assembling control knobs, etc., on to capacitor spindles, the forces applied should not exceed those which are applied during the approval testing of the component.

3.4 When assembling capacitors on a chassis or printed circuit board with power driven tools, it is imperative not to use the capacitor as a bearing point during the process.

4. SOLDERING AND CONNECTING LEADS

4.1 When connections are made to variable capacitors, it is important that the solder tag or any other part of the capacitor is not overheated and that the physical strain imposed on the capacitor by the connecting leads or by injudicious use of pliers, etc., is minimized.

In any case, the strains imposed should not exceed those which are stipulated in the appropriate tests of Doc. 3:01.04.1-039.

5. ADJUSTMENT

5.1 Rotor contacts are carefully adjusted to the corret pressure by the manufacturer and subsequent adjustment should not be allowed, for it may introduce other complications, e.g. crackles, noise, etc.

5.2 The practice of bending the adjuster vanes to change the capacitance value when the capacitor is assembled in the equipment should be forbidden.

6. LUBRICATION

6.1 Unless instructions are given to the contrary, it is inadvisable to provide any additional lubrication for the rotor bearing or for any other moving parts. Capacitors are lubricated during manufacture and the lubricants used are carefully chosen to satisfy certain conditions of humidity, temperature and conductivity throughout the life of the capacitor. Solvents should not be used for cleaning.

7. MISCELLANEOUS CAUSES OF DAMAGE

7.1 Equipment designers are inclined to use the variable capacitor as an anchoring point for other items in the apparatus, a procedure which often entails drilling and tapping holes in the frame of the capacitor. This practice can not be too strongly deprecated, for, apart from the strains which are inevitably set up by drilling and tapping holes, there is a possibility that the frame will be weakened, causing mechanical instability. When holes provided in the frame of the capacitor are used for anchoring brackets, etc., it is important that the brackets or other items are made from a thin material which will not introduce strains in the capacitor frame.

Metal stamps should not be used for cutting identifying numbers or letters on the metal parts of capacitors. This can cause permanent distortion of the frame and render the capacitor useless.

7.2 It is bad engineering practice to use any part of the rotor or stator vane systems as an end stop. If necessary, equipment designers should incorporate properly designed end stops in the drive mechanism.

7.3 Machining operations by users on the rotor spindle such as the drilling of cross holes, re-shapping, sawing, etc., will inevitably cause damage to the rotor bearings and should not be permitted.

7.4 Damage to rotor and stator vanes is often caused by fixing screws which protrude too far into the capacitor. It is essential for this to be borne in mind when the length of capacitor fixing screws is being specified.

8. MEASUREMENTS

8.1 When capacitance measurements are made on variable capacitors, it is important that the accuracy of the dividing head used for determining the angle of rotation is not lost by play in mechanical couplings, grub screw, etc. The decision whether or not a capacitor is within the capacitance limits of the specification shall be governed by the capacitance measuring accuracy as defined in Doc. 3:01.40.1-039.

A N N E X VII

BASIC TEXT FOR THE DRAFT STANDARD ON VARIABLE CAPACITORS - TERMINOLOGY

FOREWORD

This standard defines the terms needed for elaborating the standards for methods of tests for variable capacitors.

It is based on IEC 418-1.

1. SCOPE

1.1 This standard covers the terms and definitions for variable capacitors.

2. TERMINOLOGY

2.1 Variable capacitors

A capacitor which is designed to enable the capacitance to be varied continuously over its complete range.

2.2 Differential capacitors

A capacitor comprising two isolated stators which are operated with one rotor, arranged so that as the capacitance between the rotor and one stator increases, the capacitance between the rotor and the other stator decreases, but the sum of the two capacitances [illegible] remains substantially constant at all settings.

2.3 [illegible]

[illegible]

2.4 Section

A stator and its corresponding rotor.

2.5 Multi-section capacitor

A capacitor which has several sections, the capacitance values of which are varied simultaneously by a common actuating device.

2.6 Reference section

That section to which other sections are matched.

2.7 Matching section

A section matched to a reference section.

2.8 Type

Is determined by the function and is governed by the ability of the capacitor to withstand various severities of mechanical endurance.

2.8.1 Type A

A capacitor which is intended to be operated frequently throughout its life. When used for tuning purposes, this capacitor may be provided with a control spindle to which a knob or drive may be fitted.

2.8.2 Type B

A capacitor used for trimming or for other similar purposes, where the amount and duration of movement of the rotatable electrode is considerably less than that of Type A.

2.8.3 Type C

[illegible] during its life.

2.9 Style

The method of varying the capacitance.

2.9.1 Style 1 - Concentric

An air dielectric capacitor where the capacitance can be varied by rotating the rotor vanes between the stator vanes.

2.9.2 Style 2 - Vane

A capacitor where the capacitance can be varied by rotating the rotor vanes between the stator vanes.

2.9.3 Style 3 - Tubular

A solid dielectric capacitor where the capacitance can be varied by the axial movement of an electrode within a tube.

2.9.4 Style 4 - Compression

A capacitor where the capacitance can be varied by compressing a stack of electrode and dielectric layers.

2.9.5 Style 5 - Disk

A solid dielectric capacitor where the capacitance can be varied by rotating a metal or metallized disk.

2.10 Descriptive code

The description of the type (function), dielectric, style and application of a capacitor may be in the form of a four character code as follows:

Descriptive code
type (function) C 2 3 1

[illegible]

Descriptive code Type (function)	C 2 3 1	
Style	3	1 = Concentric 2 = Value 3 = Tubular 4 = Compression 5 = Disk
Application	1	1 = Grade 1 - Professional 2 = Grade 2 - Domestic

Example: For a pre-set capacitor, solid dielectric, tubular style, for professional application, the descriptive code is C231.

2.11 Maximum capacitance

The value which is obtained with the actuating device adjusted in the manner prescribed in the relevant specification.

2.12 Minimum capacitance

The value which is obtained with the actuating device adjusted in the manner prescribed in the relevant specification.

2.13 Capacitance swing

The difference between maximum and minimum capacitance values.

2.14 Capacitance law

The relationship between capacitance and the position of the actuating device.

2.15 Effective angle of rotation

[illegible]

2.16 Total angle of rotation

The angle (or number of turns) through which the rotor moves between the end stops. If there are no end stops, the the total angle of rotation is the effective angle of rotation.

2.17 Nominal angle of rotation

The angle used for determining the measuring points when capacitance law measurements are made.

2.18 Backlash

The difference in capacitance (expressed as a ratio) obtained at a specified measuring angle when the actuating device is moved to approach this measuring angle from a clockwise and then from an anti-clockwise direction.

2.19 Apparent power

The maximum VA rating at which the capacitor can be used in relation to temperature rise, in terms of frequency, current and voltage.

2.20 Lower category temperature

The lowest ambient temperature at which the capacitor is designed to operate continously.

2.21 Upper category temperature

The highest ambient temperature at which the capacitor is designed to operate continuously.

2.22 Category temperature range

The range of [illegible] for which the [illegible] is designed to operate [illegible]ly.

3 Capacitance drift after adjustment

The change in capacitance (expressed as a ratio) obtained in a stated time after the actuating device has been rotated at a specified speed to a stated capacitance.

4 Nominal capacitance

Those values which are indicated upon the capacitor or the package. These will be defined in the relevant specification and will comprise one or more of the following:

- Capacitance swing (nominal)
- maximum capacitance (nominal)
- minimum capacitance (nominal).

5 Rated voltage

The maximum peak voltage which may be applied continuously to the terminals of a capacitor at any temperature in the category temperature range.

Note: Rated voltages shall be selected from the R5 series given in ISO R3. Where intermediate values are required, these shall be chosen from the R10 series.

6 Rotor contact resistance

The resistance between the rotor contact terminal and the rotor shaft.

7 Type tests

[illegible]

2.28 Type approval

The decision by the proper authority (the user himself of his nominee) that a particular manufacturer can be considered to be able to produce in reasonable quantities the products meeting the specification.

2.29 Acceptance tests

Tests carried out to determine the acceptability of a consignment on the basis of an agreement between user and manufacturer. The agreement shall cover:

a) the sample size

b) the selection of tests

c) the extent to which the test specimens shall conform to the requirements for the selected tests of the specification.

Note: When different test results are obtaine by user and manufacturer, the referee tests shall be used for confirmation.

2.30 Factory tests

Those tests carried out by the manufacturer to verify that his product meets the specification.